THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXXV. AUGUST, 1908. No. 5.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

II. NATIONAL EFFICIENCIES; THEIR TENDENCIES AND INFLUENCE.

Mr. Emerson's series began last month with a review of typical inefficiencies and their significance. In the part now presented he sketches most graphically the peculiar qualities which have caused the greatness of the leading industrial nations—Great Britain, Germany, France, Japan, and the United States—using the past and present thus revealed as a basis for the deduction of very valuable suggestions for the future. Next month's paper will take up the "Strength and Weakness of Modern Organization," and the following part will begin an examination of the averages attained in standard practice.—THE EDITORS.

INEFFICIENCY is a form of waste, of loss; it lurks everywhere—in processes, in materials, in individuals and in nations. There is however a difference in kind between the two forms of inefficiency, one manifest in processes and materials and the other manifest in individual or nation. To the efficiency of a process or in the use of a material there is a clearly ascertainable maximum, and when it is exceeded the material gives way, as in the Quebec bridge, but to the efficiency of an individual or of a nation there is no predeterminable limitation. In the passion for modern scientific accuracy it has proved more interesting, and more has been done, to solve the lesser problem of efficiency, in process or material, the larger problem of individual or national efficiency being in fact almost wholly ignored.

Men are quick to catch and appropriate the ideas of other designers as to bicycles, steam engines, gas engines, automobiles, so that the same standard designs and performances occur in widely scattered countries; but individuals and nations differ fundamentally not nearly so much in the degree as in the nature of their characteristics. They differ not as one coal from another, but as sulphur, carbon, hydrogen and radium differ. The analogy of fuels is il-

luminating and may further a better understanding of the whole question of efficiencies. If a coal yields 13,000 B. t. u. the combustion problem is to utilize as large a percentage of them as possible. Other elements in combination with oxygen may evolve only 4,000 B. t. u. per pound, as sulphur, or 60,000 as hydrogen; or radium, without troubling to combine with oxygen, will evolve per pound 210,000,000,000 B. t. u. or thereabouts.

It is the province of the chemist to determine the actual number of heat units in any element or combination, so that we have, for each, a theoretical maximum. It is the task of the combustion engineer to devise apparatus which will utilize the largest percentage of the heat units in the fuel; but the more difficult problem of the economic engineer is to select the fuel and burn it so as to secure the desired result at lowest cost.

It is more difficult to select intelligently the power installation for a tug boat, between the limits of a drift-wood burning furnace and a Diesel crude-oil motor, than it is to design and secure good furnaces, good boilers, or good engines. A very elementary furnace and boiler will yield 50 per cent efficiency; the best boiler and furnace, and then only under exceptional test conditions, may yield as much as 85 per cent; and no increase of expenditure, no increase of designing skill, will realize 90 per cent. When, however, one passes from sulphur to carbon, from carbon to hydrogen, from hydrogen to radium, the progression is not one of 80 per cent improvement between best and poorest, but the best, radium, is fifty million times better than the poorest, sulphur.

Applying the analogy of fuels to individuals and nations we have as yet no analysis of humanity which will enable any one to determine their capabilities. We do know how the best individual will react against some definite mechanical proposition; we do know the best record as to running or swimming or any other athletic or manual performance, with the certainty that it will never be appreciably bettered; but even this knowledge has as yet been utilized to very small extent, outside of sport, to increase individual efficiency in a particular task. Our manipulators of human material are constantly using human radium on a grate intended for lignite coal, very much as the early engineers in the natural-gas fields used natural gas expansively to drive engines originally built for steam.

The difference between sulphur and radium as evolvers of heat is fully paralleled in the difference between the Italian immigrant (who, with wheel-barrow, works at less than 20 per cent efficiency

on the railroad dump), and the Corsican, of poverty-stricken antecedents, who in early manhood pushed the whole of Western Europe and also the two Americas a hundred years forwards. It is not assumed that every immigrant boy is an embryo Napoleon; but from John Jacob Astor on, foreign immigrants who would have remained peasants in their own country, have become dynamic forces in the New World, simply because, to these radium individuals, opportunity occurred.

As to any man, and as to any nation, the as yet unsolved problems of efficiency are: (1), to enable each to accomplish the uttermost in reaction with the task set, average present efficiencies being about 60 per cent; and (2), to set each at the highest task of which it is capable, present average efficiencies being so much below one per cent of the best as not to warrant an estimate.

The differences between coal and coal are molecular; the differences between sulphur and radium are atomic. The differences between the speed of one runner and another, the natural resources of one nation and another, are physical; the difference between the spirit of Diogenes and the spirit of Napoleon, between the spirit of the Papuan and the spirit of the American, are psychical.

Inherited wealth and inherited power have rarely made men great, although when young heirs first come into their inheritance they may for a short time dazzle by their prodigality. Great natural resources will not in the long run maintain nations, although during the period of reckless squandering they may seem prosperous to themselves and to others. For the past 10,000 years Central Africa has teemed with natural resources, but it was the Vikings of bleak Norway who conquered the European and Mediterranean littoral, incidentally also taking possession of Iceland, Greenland, and probably visiting the northeast coast of America.

Alaska is a better country than Norway or Switzerland. It has 100,000 square miles of agricultural land, the best coal in North America, lead, copper, silver and gold mines, vast forests, rich fisheries, a great fur trade, and 10,000 miles of ice-free sea coast, harbor-indented, along the great Pacific highway between all Asiatic and all North American ports. The Eskimo, Aleuts, Indians, and mongrels of Alaska, surrounded by unparalleled natural resources, have accomplished little, although their supineness has been no greater drawback than the stupendous ignorance, neglect, and corruption to which this empire of the future (if men are forthcoming) has been subjected by some of the departments at Washington. The Swiss, for

whom nature has done so little, have, individually and nationally, developed high efficiency. When Alaska, the relatively richer country of the two, has as many inhabitants as Switzerland in proportion to its area, it will be a nation of 120,000,000. No wonder the Canadians, with nearly six times the area of Alaska, have hopes of repeating in America the polar drift of empire so manifest in Europe, Asia, Africa, and South America.

Between one civilized country and another there are extremes of variation in natural resources, yet all are prospering. The efficiency of the workers in all of them is low, yet each country is growing rapidly in wealth. The cause of prosperity cannot lie in natural resources, since some of the countries with the most resources are most backward and others with the poorest resources are most forward. The cause of prosperity cannot lie in the ability or fidelity of the workers, since all of them, when checked up, are found to be of low average efficiency. The cause of success must therefore lie either in some common trait which all possess or in the exploitation of some different trait in each. The only common trait is ambition, the desire for success and wealth; but the gratification of ambition, the attainment of material success, has each time been due to a different psychical instinct. In Alaska the eagle, the seal, and the bear all grow fat by feeding on salmon. The food is common to all three, but the method of appropriation is different. The eagle descends from the air, and lifts the salmon out of the sea, the seal pursues and seizes the salmon in the water of the sea, and the bear scoops him out with his paw when he finds him in the shallow brooks. The British, French, Germans, hunt success along lines as different as those of the eagle, seal, and bear. It is easier to describe the physical differences between eagle, seal and bear than to describe the psychical differences between the great industrial nations. Nevertheless the differences exist, and the causes of the respective successes cannot be understood unless the reaction of success of these psychical traits is understood; and, what is more important, that nation will in the long run reach a higher level which is able not only to appropriate the best designs and processes of its rivals but, what is immeasurably more important, to appropriate also and possibly to improve their psychical inspirations.

The English, the French, the Germans, the Japanese, the Americans, are not great because they all have schools and sea ports and coal, but because schools and sea ports and coal mines have fed wholly different natural characteristics. To discover these different national

characteristics it is necessary to back off, both in space and time, so as to lose details and see only the governing traits. No nation can be reduced to a formula, but an attempt will be made to separate out, for a number of leading industrial nations, traits of which they more or less seem to possess a monopoly, and which for that very reason merit careful analysis by their rivals.

In recent centuries Great Britain has been easily the leader both commercially and industrially. The English also were up and doing before daybreak in other directions, and by the time the other nations woke up, either yawningly or to the sound of some revolutionary alarum, the English were anywhere from several decades to several centuries on their way. They limited the power of kings, 1215 A. D.; they abolished divine right in 1649, and selected by vote their own sovereign in 1689. The American colonists woke up in 1776, the French in 1789, the Germans in 1871. During the period when other nations were pulling each other down in continental Europe, the English were appropriating large parts of Asia, America, and Africa as well as the continental islands. When other nations were using wood and developing charcoal burners, the British were opening coal mines. When other nations were building post roads, the British were stringing iron rails; when the Americans were building the best and fastest wooden clipper sailing ships, the British were not only building iron steamers, but they were also calmly taking possession of all the strategic points of the seven seas. While other nations were stretching wires on poles along railroad rights of way within their own boundaries, the British were enmeshing the globe with submarine cables. It is not because the British are the greatest shipbuilders that they control the sea, but they incidentally build ships and a few other things because at least 100 years before any one else realized its importance, they made the unclaimed empire of salt water their own. For any other power at this late date to aspire to rivalry on the sea is futile—is laughable.

Consider the North Sea. Sweden, Russia, Germany, Holland and Belgium, all the immense maritime trade of Northern Europe, goes to and comes from the Atlantic Ocean and all there is beyond, through what the English proudly call the English Channel, with the cliffs of Dover at one end and on one side and the Channel Islands at the other end and on the other side. Consider the Mediterranean, bottled up at one end at Gibraltar and at the other by the French-conceived, designed, and dug, but at present English-owned Suez Canal, with Malta conveniently and centrally located in the waist, with

Cyprus watching the egress from the Black Sea of both Turk and Russ. The only nations in Europe who can go to sea without British consent are the Norwegians, the French, the Spanish and the Portuguese. Consider the Atlantic Ocean, north and south, studded with British mainland ports and island outposts along all its four sides, and up and down through the middle. Consider the Indian Ocean—Cape Colony at the western southern end, Australia at the eastern southern end, the western northern entrance blocked at Aden, the eastern northern entrance blocked at Singapore, with Mauritius, Ceylon and sundry other islands scattered centrally around, very useful for all sorts of purposes, coaling and repair stations, landings for submarine cables, shores for space telegraph installations. Consider the Pacific Ocean —not quite so completely a British sea, but nevertheless even in it they would be first in length of sea coast were it not for Alaska's indented mainland and islands. Although second, as to mere length of shore line, they have, both on American and Asiatic side, strategically a greater number of important posts, not counting Australia and New Zealand to the South, than any other power, and when the all-British cable was laid from Vancouver to Australia and New Zealand, as many British islands as were needed turned up conveniently for mid-ocean stations.

Not content with commanding the European Mediterranean, they also command the American Mediterranean, with the counterpart of the Suez Canal in the St. Lawrence River, the deep-water channel between the Great Lakes and the Atlantic. They also control one side of the water passage from Lake Superior to Lake Huron, from Lake Huron to Lake Erie, from Lake Erie to Lake Ontario. On the Pacific side of North America it is the same. There is another though smaller inland sea there, the matchless Puget Sound, but, in spite of 49 degrees north, the treaty boundary line, they not only reserved their own independent sea outlet, north of Vancouver Island, but they established another Gibraltar at Esquimalt, on the north side of the Fuca Straits, only entrance to the largest and most important American harbor on the west coast.

Although the United States at last controls Panama, during the whole of the last century it was not any American statesman who foresaw the importance of this control, nor was it any American ambition that dared attempt the task of breaking the Isthmus.

Two-hundred years ago the British appropriated a complete chain of islands cutting off both Gulf of Mexico and Caribbean Sea from the Atlantic Ocean; in 1827 Goethe, in a masterly discussion of the importance of the Isthmian Canal said: "I would be surprised, if

the United States would miss the chance to get such a work into her own hands. It is entirely indispensable for the United States to make the passage to the Pacific Ocean, and I am certain that she will accomplish it." It was however not the near-by United States that first undertook the work, but the distant French.

So early and so persistent was the British instinct of sea control that surprise is caused, not that the British have so much, but that they let so much of value slip through their fingers.

By right of exploration they might have taken possession of the whole of equatorial Africa; they might, without any one making protest, have annexed both sides of the Straits of Magellan; they might have seized on both the Diomede Islands in the middle of Bering Straits; and it is incredible that after discovering the Hawaiian Islands they should have let them go.

For the British these islands have strategic location and value as the only direct sea route on which they are situated is the one between Vancouver and New Zealand. They are of no value strategically to the United States, as they lie at least 1,000 miles south of any direct route from the United States to Asia, lie 1,000 miles out of the course of steamers making the run from Panama to Singapore, and the attempt to magnify them as an important sea possession of the United States merely accentuates the difference between the deep, set purpose of the English and a fatuous impulse.

So sensitive are the British as to anything that appertains to the control of the sea that they get into a panic at the mere suggestion of tunneling the English Channel, and when the Germans built the fastest steamers for the Atlantic trade the English did not rest until they had evolved a new form of steam engine, a new form of screw propeller, had built larger boats than any other flag possessed, and with the combination, regained the lost blue ribbon of the sea. Similarly, as soon as the French, Germans, Americans laid a few straggling sub-oceanic cables, the British at once set up space telegraph stations so that soon no British steamer anywhere need be beyond call from British land.

This persistent far-sight, this stubborn holding onto an idea, characterizes the British bull-dog in all things, although illustrated above only as to sea power; and it is perhaps well for the rest of the world that on the whole he is good-natured and that he does not have too many ideas.

The predominant characteristics of the French are quite different; none the less admirable—in fact, more progressive. The French

are brilliant innovators and as a nation they think logically and execute artistically. Their revolution had its inception in the work of the encyclopedists, and its culmination in the Code Napoleon. In the Théatre Français the prices of the seats are cut into the solid marble, but the monogram of the government is detachable, because forms of government are the accident of the moment but the principles of art are eternal. The English follow up persistently a few all-important matters. The French evolve brilliantly many entirely new things. The French invented and made practical the bicycle, the French were the first to ascend into the air in balloons, and France still holds all the official records for all sorts of flight—distance, dirigible, heavier than air. The French started both the gas engine and the automobile; they first used rapid-fire machine guns, the mitrailleuse; their passenger locomotives make the fastest regular runs in the world; they developed compound locomotives, and also, the most powerful freight locomotive, the Mallet articulated, is of French design. To the French we owe the first successful submarines; to a Frenchman, Daguerre, we owe photography, and to another, pyrometry which has placed metallurgy on a scientific basis. The French invented and put into effect the decimal system, which has been universally adopted for money (except by the insular British) and the French also established and maintained bi-metallism, without a hitch, for 70 years, although in that period the greatest fluctuations that the world has ever experienced occurred in the relative production of gold and silver. The French have always been bright enough to avoid the financial panics that have disgraced Great Britain, Germany, and the United States. The French dug the Suez Canal and also started the works at Panama. Most appropriately, we owe to the French modern stearine candles, the Argand burner, and the brilliant use of the electric current for light. Storage batteries of both types were discovered in France, as also plate glass, rolled glass, and wire glass. A Frenchman first deciphered the hieroglyphics of Egypt; another Frenchman, Pasteur, expanded and made rational the practice of inoculation; another one, Berthelot, developed modern chemistry, and to the French we owe artificial silk.

It was because the French teem with revolutionary ideas that Franklin's ability received from them more immediate and cordial recognition than from either Americans or from British.

The characteristic trait of the French is brilliant innovation carried out in an orderly, logical and artistic manner.

Germany is one of the world's greatest industrial powers—so menacing, in fact, that the eyes of the industrial and commercial

world are turned apprehensively in her direction. Until recently however she has always been bringing up the rear, the slow but sure turtle among the nations. When France, Spain, and England were parts of the Roman Empire, assimilating Roman civilization, Germany was a storm center of savage ferment. Italy officially adopted Christianity in the fourth century, France became Christian in the fifth century, but it was not until the ninth century that Charlemagne gave the Saxons their baptism of blood. When the French and English were evolving parliaments and courtly manners, the Germans were engaged in their thirty-years war. It is characteristic that the renascence in Italy and France took the form of a revival of classic art, literature, and culture; in Spain and England took the form of oversea adventure; but in Germany the form of religious revival and reform. It is also not less characteristic that while other nations have made progress through revolution and violence, the Germans are rapidly overtaking them through peaceful evolution.

American wooden clipper vessels were the queens of the sea from 1800 until the introduction of steam. Previous to 1870 the only German ship-building was in the Baltic yards where American models were imitated, but shortly after 1870 Germany "resolved" to build ocean steamers and in 25 years her ocean liners, German designed, German built, German manned and officered, were the fastest and finest vessels afloat. It required extraordinary effort on the part of the English to regain the lead. America built more locomotives and owned more miles of railroad, many times over, than Germany, but in this year of Grace 1908 it is the German principle of superheating that is being applied to American locomotives.

Germany succumbed helplessly before the genius of Napoleon in 1806, but less than two generations later Von Moltke had remodeled the oldest of all organization—military—by adding to line organization the principle of developed staff organization, and it is staff organization that has made Germany during the last 40 years easily the pre-eminent military power in the world.

An English authority on iron and steel has recently shown that in spite of adverse natural and economic conditions which make the average production cost of German pig iron 50 per cent higher than the average cost of British warrants, yet owing solely to better organization and more advanced industrial discipline, German exports of iron and steel increased 350 per cent in the decade from 1897 to 1906-7 while the British increase in the same period was only 10 per cent.

This habit of the Germans of "resolving" that they will accomplish certain results, and then forthwith succeeding, is exceedingly disconcerting to commercial and industrial rivals. Whether the subject be military organization, the designing of ocean steamers or of locomotives, technical or industrial training, industrial and commercial expansion, all the German needs to do is to desire to surpass and he succeeds, not by far-sighted annexation of a field not yet taken, not by brilliant creation of a new field, but by patient improvement on the model supplied. "Billig und schlecht!" said Prof. Reuleaux of the German exhibits at the Centennial in 1876; "made in Germany," the legislative badge of inferiority in 1880; but today German products are no longer "billig und schlecht" and, in many lines "made in Germany" is a label of highest excellence.

It is fortunate for their rivals that German efforts are so often indiscriminate, that they will elaborate mathematically the theory of the Dutch windmill and overlook the sirocco blower, that they perfect staff organization in the army and that they have failed to apply it to their shops, being in this respect far behind the best American developments!

Americans have little of the persistence of the English, little of the brilliancy of the French, and not any of the patient science of the Germans. The immigrants or adventurers who of their own choice, full of faith and hope, come to the land of sunshine and opportunity, were the restless daring spirits of all the nations of Europe; first the Spaniards, then the French, later the English, and more recently the Irish, the Germans, the Russians and the Italians. For all these the past held but light ties; they came to stay, and the little they did bring of mental or material equipment proved of scant value. There has been in all of them, of whatever decade or nationality, the common restlessness, the common eagerness to make good. Before them stretched out the promised land, forest and plains, farms and urban sites, transportation monopolies, minerals. The gold-seeker in California, equipped with elementary courage and pick and shovel, exhausting the shallow placers, and spending the proceeds in individual aggrandizement; such is the true type of the American, whether he be named Astor or Vanderbilt, Rockefeller or Morgan, Jas. J. Hill or Harriman, Carnegie or Guggenheim. Because there were no traditions to hamper, because those prospered most who acted most energetically, American enterprises have been characterized by spasmodic and disconnected impulses, very different from the dogged pluck of the English or the logical development of the

French or the studied results of the Germans. In America personality has been everything—personality inbred until often in one generation it became sterile from lack of cross fertilization. Because of different personality, not because of different problems or different opportunity, the New York Central and the Pennsylvania Railroads have grown and prospered, but the Erie Railroad, between the same terminals has always been in difficulties; and because of varying personality, far more than varying conditions, such railroads as the Union Pacific, the Northern Pacific, have swung up and down and then up again between extremes of inflation and depression. Not in religion, politics, transportation, commerce or industry is there either persistence or clear thought or profound preparation.

An agent of Lloyd's visiting the Atlantic Coast ship yards of the United States reported that American materials were fully as cheap as English materials, that American wages were no higher than British wages, but that the very greatly increased cost of American-built ships was due wholly to the enormous inefficiency of organization and performance. Yet, when the mood takes the American, creations more stupendous, more beautiful than the world had ever dreamed of, suddenly spring from nothing, as in the filmy beauty and sublimity of the World's Fair grounds and building at Chicago, but as suddenly these creations fade back into nothingness leaving only a memory.

The American, whether at Chicago in 1903, or on the Alaskan White Pass in 1899, crowds the progress of 2,000 years into a single year; but to mark the milestones of time, he leaves no pyramids nor cathedrals, nor palaces nor anything else that holds out a promise of secular endurance. Individuality has been supreme, it has accomplished so much. There have been great inventors—Edison, Westinghouse, F. W. Taylor—but what they have created has rapidly become the property of all mankind. When lavish opportunity no longer exists, when invention becomes less the inspiration of the moment and more the result of patient research, how then will it fare with the American in the cosmopolitan struggle for first place?

Latest of the civilized nations are the Japanese. The occidental world was opened to them by Perry in 1853 and as late as 1867 they were still using bows and arrows, two-handed swords and chain armor. The Germans and the Japanese (not counting oriental Europe) emerged latest from feudalism and rose into world prominence about the same date, and for that reason both have proved dangerous, because both were compelled to absorb so much from others, and yet were able to supplement it with their own special virtues. The Japan-

ese, with an open-mindedness unparalleled in the history of the world, sent forth their brightest young men to England, to France, to Germany, to the United States; they adopted eclectically all that was best, adapted to their own needs what they had selected, and soon they became adepts. They have sat at the feet of the English in all matters appertaining to the sea, from ship yards to ship officers, from ship models to ship insurance; they have sat at the feet of the Germans in all matters appertaining to military organization, and, as the expedition to Pekin and the Russian war showed, improved on their models; they are as logical as the French and more progressive than the Americans.

Ascribing to the English the efficiency of wise anticipation and continuous persistence, to the French the efficiency due to their innovations of supreme value and merit, the efficiency of the Germans to their perfection of organization, discipline and scientific minuteness, to the Japanese the efficiency due to open-mindedness and marvelous power of assimilation, to the Americans the efficiency due to individuality—it cannot be doubted that it would be more desirable and produce better results to endow a nation of individuals with persistence, clear habits of thought, scientific patience and open-mindedness, than to let loose intense individuality among the English, French, Germans and Japanese. The trouble with the American is that as yet he is provincial, skeptical as to the value of anything outside his own limited experience, a trait perhaps amusingly illustrated in the way he takes for granted that millions of foreigners shall cheerfully give up their allegiance for the sake of American citizenship, but is indignantly surprised when any American seeks naturalization in Europe.

The boundless natural resources of American are being exhausted. Will the American forever be able to maintain a lead through intense individuality alone, or will he industrially as a nation recede before the German, even as native American names have disappeared from Broadway, New York, and been replaced by miles of German names? Will mere resourcefulness suffice in the future? Because he is resourceful, because he is adaptable, because he has always delighted to force the game to the uttermost, it may be that all he needs is a set of higher standards, and that if they are supplied he will realize them sooner than any competitor.

Standards except as to a few performances are as yet undetermined in the industrial world. If the American sets them high, he may attain them, and the prevalent democracy may make it easier for each worker to rise to the limit of his capacity.

THE EXCAVATION OF HERCULANEUM BY MINING METHODS

By Alex. Del Mar.

THE Roman city of Herculaneum (the Heracleia of the Greeks), which was injured by an earthquake in A. D. 63, and buried by an eruption of Vesuvius 16 years later, lies now from 30 to 120 feet beneath the surface, at a distance of about 5 miles southeast from Naples, with the town of Resina (population 20,000) on top of it and the overlying space filled with volcanic material. It is distant about five miles westward from the most recent crater of the volcano, about two-thirds of a mile from the Portici Station of the Naples-Pompeii Railroad, and about half a mile from the seashore and the continuation of the railroad line, which here hugs the shore.

The ancient city was not built upon a level, but upon a bluff descending to the sea, with the result that some of the buildings differ in the altitude of their foundations by 100 feet or more. Excluding scattered villas, the buried ruins probably extend over several hundred acres, of which less than 40 acres, constituting the higher and more easily accessible portion of the city, have already been laid bare, or rudely excavated, by means of tunnels.

The origin of Herculaneum, its ancient history, its tragic catastrophe, the various excavations of its ruins made in the reign of Constantine the Great, and again between 1709 and the present time; and the manuscripts, sculptures, paintings and other objects of interest rescued from its ruins in modern days, form the subjects of a very considerable literature, an epitome of which and a guide to the works themselves will be found in the current encyclopedias and other works of reference, and in magazine articles. Among the latest of these is the brief but interesting essay of Professor Rodolpho Lanciani, in *Munsey's Magazine* for 1907.

The most valuable objects thus far recovered from the ruins consist of statuary, paintings, vases, and coins; and the most numerous objects, several thousand manuscripts; but among them, so far as has been disclosed by the excavators who had charge of the works under the Neapolitan princes of the eighteenth and nineteenth cen-

turies, none of those productions of the Augustan age of Rome, which, like the missing books of Livy or Tacitus, would have earned for the excavators the gratitude of an expectant world. These are among the prizes which await the future explorer: for it is confidently believed that Herculaneum, which Lanciani has aptly termed "the Newport of Rome," still hermetically preserves in its tenacious care the lost literature of the classical ages.

A portion of the excavations of Herculaneum thus far made are what a miner would call an "open-cut," where all the superincumbent earth, or volcanic material, has been removed, and the buried remains laid bare to the day, as in the Roman Forum and in Pompeii. Another portion has been excavated underground by means of shafts and galleries, as in a rock mine; and still another portion, by means of short tunnels run in from the seaside, as in a drift mine. All of this work, except the open-cut (which though very expensive was mechanically simple) was done, from a miner's point of view, unscientifically, and from the archæological point of view, as Lanciani observes, vandalically.

Some years ago, Prof. Charles Waldstein, of King's College, Cambridge, attempted to enlist the aid of a number of eminent and wealthy persons in England, Italy and the United States, in raising a fund to purchase the lands of Resina and remove the entire mass of volcanic material which covers the city of Herculaneum; but without success. The enterprise was deemed too vast and the plan too expensive. An American company now proposes a different plan—that of exploring Herculaneum as a rock mine and with all the mechanical appliances and devices which have elevated the art of mining in America to the dignity of a scientific industry. The outline of the plan proposed has already secured the approbation of Prof. Spinazzola of the San Martino museum of Naples, Prof. Dall'Osso, inspector of excavations at Pompeii, Prof. Cosentini of the University of Naples, and Prof. Lanciani, University of Rome, and other eminent scientists in Italy, besides many distinguished persons in England, France, Germany and America. It is the details of this plan which we propose to lay before the reader; it being premised that as yet, the writer, who has been nominated by the American company to superintend the mining works, knows the ground only by casual survey and description. Upon exploring it more minutely, some of the following details may undergo modification.

The material to be dealt with consists for the most part of tufa, or a semi-hardened volcanic mud. The theatre, already excavated,

was found filled up to the very head of the arches with tufa, and under circumstances which prove that the conversion of mud into this stone takes place in a comparatively short time. Until exposed to the atmosphere it yields readily to the pick: afterwards it hardens into pozzolana, or pudding stone, when it becomes refractory. Other portions consist of sand, ashes, fragments of lava and whitish pumice, inclosing grains of uncalcined lime, similar to the materials found in Pompeii. These were evidently transported by water, hot from the volcano; for they sometimes fill and choke up the most narrow, intricate and remote places, and in a manner that no subsequent seepage of rain water from the surface could have effected. In some places streams of hardened lava are covered with soil and again by lava, and so on for six successive times, implying long ages between the various floods of volcanic materials. Briefly, the engineer will have to deal with hard lava, pozzolana, tufa, pumice, sand, and seepage water, to say nothing of other and as yet unknown materials, such as underground springs of water; structures which have fallen into and choke volcanic fissures; old workings unskilfully constructed, or defectively supported; etc.

It is proposed at the outset, and until the workings suggest different openings, to excavate Herculaneum by means of four principal openings, two vertical and two horizontal, of which only one pair will need to be described; the other pair being, for all engineering purposes, merely duplicates. One of the perpendiculars, which will be called the main shaft, will tap the ancient city at a point between the theatre and the seashore; the corresponding horizontal entry will penetrate from the seashore until it connects with the main shaft. This plan will secure several important advantages. It will afford a natural drainage for the entire workings; it will afford an easy and economical exit for the material to be removed and transported by gravitation to a point where it can be utilised for other purposes; and it will afford an avenue of egress for the workmen and inspectors, in case of temporary interruption to the working of the main shaft.

To facilitate and cheapen the work of excavation, a compressed-air plant will be installed which will run sufficient air-hammer drills of the most approved type to hasten the work in any ground that requires blasting. The exhaust air from the drills will improve the ventilation in remote places not easily reached by natural draft.

As, in conformity with the plan of the undertakers, Herculaneum will become a popular show place, to which numbers of people, both natives and foreigners, will resort, to view its remains of antiquity

in situ, it is proposed to construct the main shaft in an enduring manner, and both earthquake- and fire-proof. Instead of the usual timber frame and board sheeting, the main shaft will be constructed throughout of steel. It will be sunk from the surface to a depth below which it will be useless to search for antiquities. It will have at least four stations, one at about the level of the roofs of Herculaneum, one at the level of the principal street, one at the level of the cellar floors of such street, and another to connect with the seashore tunnel. The main shaft will be divided into three compartments; two for workmen and freight and one for visitors. The former will be provided with safety cages, and the latter with a luxurious elevator, handsomely furnished, and worked by an independent engine. After connection is made with the tunnel, one of the workmen's cages will be dispensed with, and converted into a supplementary passenger lift. The head of the main shaft will be enclosed in an edifice constructed to suit the purposes of the administration, including a visitors' room, inspectors' room, sifting room, ticket office, etc.

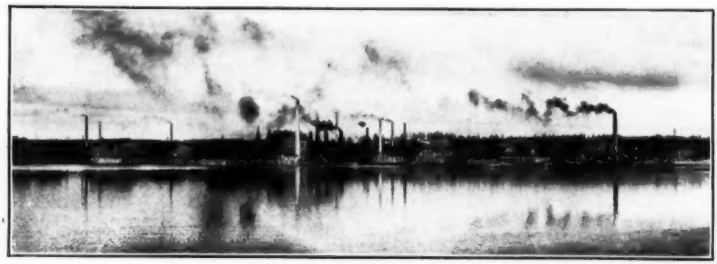
In order to meet the necessary requirements of the administration, the exit to the tunnel will also be enclosed. This tunnel will be 2.2 metres, or about 7 feet high; and 1.4 metres or about 4½ feet wide. At the bottom of the tunnel, in the centre, will be constructed a drainage channel; and on each side of this channel will be laid a line of narrow-gauge rails, upon which will run the dump cars employed in transporting the excavated material to the sifting room, and eventually to the seaside. The tunnel will form a more or less direct line from its mouth to the main shaft; but cross-cuts will be driven wherever these can be made to advantage. As the line of the tunnel will form a continuous descent from the main shaft to the sea, nearly all the excavated material will be removed by gravity and at small expense. At first the empty cars will be pushed by hand; eventually the entire system will be worked by machinery, and in a system by which the momentum of the loaded cars will be utilised to haul up the empties.

One of the most important cares of the engineers will be to support the superincumbent earth and the edifices of Resina which surmount it. This will be done in various ways, one of which will be to leave untouched all those portions of the mine, or buried city, which contain no structures. These portions comprise all the open spaces, such as the ancient gardens, empty lots, and sections of the streets, or roadways. In addition to the natural supporting pillars thus to be formed, it may be necessary in some places to construct

artificial supports by devices familiar to the miner. When it is remembered that the Comstock mine, six miles in length, containing the numerous huge chambers from which the "bonanzas" had been extracted, were excavated, while Virginia City with its numerous heavy structures reposed in perfect security on top of the mines, there need be no fears that the difficulty of supporting the smaller city of Resina will be overcome in an equally satisfactory manner. The bonanza cavities of the Comstock mines reach downward to a depth of over 2,000 feet, and the shafts, galleries and other workings, downward to a depth of over 3,500 feet; yet Virginia City remains and the workings continue. The horizontal area of cross section of its bonanza cavities may be realised from the fact that, upon a floor filling one of these, an opera was performed before a large audience, with plenty of space for proscenium, scenery, dressing-rooms and orchestra.

The Herculaneum openings will be lighted throughout by electricity, and so vividly as to leave no part of the workings obscure. To provide against accident to the electric works, an independent electric system of lighting will also be installed; and as additional security, provision will be made for a third system, independent of the others, the details of which the engineers do not desire to make public. The telephone will be installed throughout the workings, and telephonic slot-box stations, open to the public upon deposit of a small fee, will be erected at convenient points. Refectories and other places of entertainment for visitors will be provided by the administration; so that an entire day may be spent in the Habitation of the Past, with both edification and pleasure.

The subterranean workings, by embracing the numerous detached villas of Herculaneum, will eventually cover so extensive an area that one of the most essential provisions of the engineering faculty will be the installation of a suitable and effective system of ventilation. Unless mephitic vapors from continuing sources are encountered—a condition of affairs which there is no reason to apprehend—such a system of ventilation is expected to be attained in a natural and inexpensive way. A continuous draft of fresh and invigorating air from the sea is expected to find its way to the shafts; and this draft can be diverted at pleasure to any desired part of the openings. Provision is made in the working plan for a cheap and effective device to overcome any interruption that may occur to the natural draft. A small fire department, with installation of running water, hose pipes, ladders, and hand implements, completes this interesting plan for the excavation and exhibition of the buried city of Herculaneum.



GENERAL VIEW OF THE SANDVIKEN IRON WORKS.

MINING AND INDUSTRIAL PROGRESS IN SWEDEN.

By John Geo. Leigh.

In a preceding article Mr. Leigh reviewed broadly the principal mining, mechanical and general engineering undertakings or projects now receiving attention in Sweden. The present paper is concerned chiefly with the individual characteristics and equipment of the leading establishments.—THE EDITORS.

AS indicated in the preceding article, the countries with which Sweden has the largest commercial intercourse are the United Kingdom and Germany. In each case, indeed, the trade is more considerable than appears from official statistics, for there can be no doubt that a not insignificant percentage of products shipped to Denmark, and consequently classed as exports to that country, are in reality destined for England or Germany. For equivalent reasons, the trade between Sweden and the United States is probably much larger than is suggested by commercial records, England being, in this instance, the "country of destination" to which the goods are first shipped. A comparative statement of the value in thousands of £ of the recent commerce of Sweden with the three nations mentioned is given below:—

	1895.		1900.		1905.	
	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
United Kingdom.....	7,268	5,433	9,402	9,805	8,855	8,002
Germany	2,375	6,456	3,624	10,438	4,733	12,464
United States.....	521*	591	875*	510	1,039*	2,302

The greater part of the Swedish exports of iron, steel, and forest products, raw and manufactured, goes to the United Kingdom, from which, in return, Sweden buys large quantities of coal and all but an inconsiderable proportion of her requirements, raw material and machinery, for her textile and leather industries. German imports include food products and luxuries and a great variety of manufac-

* Including a small percentage of Norwegian products.

tures, largely the output of engineering and chemical establishments, while the exports to Germany mainly comprise iron ore, partly wrought iron and steel, unwrought timber and joinery. From the statistics, it will be seen that Sweden's increased demands for coal—the effect, in the main, of her new-born industrial activity—have alone saved England from actual retrogression in the Swedish market, and that, on the other hand, and notably in respect of machinery sales, Germany has considerably improved her position. This, I am assured, is not the result of any natural preferences on the part of Swedish manufacturers, but rather in defiance of them, for the circumstance has occasioned more regretful concern in Sweden than, apparently, among those primarily interested and responsible. The last-mentioned, it would seem, have yet to learn that however willing the Swedes may be to acquire British machinery, they can scarcely be expected to over-exert themselves to this end in the absence of encouragement, and while it is comparatively easy to enter into arrangements with the agents of other countries, who are continually calling upon them or supplying information of mutual service.

Some responsibility, also, seems to attach to British ship-owners in fostering an impression that Sweden's industrial development is matter of indifference to the United Kingdom. The transportation and shipment of practically the entire output of iron ore, intended for export, from the central provinces and Norrland is today controlled by a single corporation, the Grängesberg-Oxelösund Traffic Company. This possesses large interests in the Grängesberg and neighbouring mining fields, and it has been in order to facilitate ore exports from these that the company has acquired shares in the railways to the coast and created a special harbour at Oxelösund. A few years ago the shipping of ore from this port was almost exclusively in the hands of British ship-owners, but since then it has been allowed to pass into those of the Dutch and Germans. In 1906 not one, and last year only one, British steamer carried ore from Oxelösund, and this in spite of the fact that each year the exports approximated 800,000 tons. The circumstance is the more remarkable as the port is open all the year, no harbour or pilotage dues are charged, and shares in the owning company are held to a considerable amount in England.

Reverting to the subject of imported machinery, I regard with no little interest the following valuation in thousands of £ of Swedish exports and imports of machinery in specified years:—

1895.		1900.		1905.		1906.	
Exports.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
307	619	643	1,281	859	1,314	1,075*	1,048*

* Approximate, and not including steam-engines or sewing machines.

The figures need little explanation or comment, for both classes, imports no less than exports, bear testimony to marked industrial expansion. Owing to geographical position and heretofore existing political exigencies, the Swedes have in a larger degree than the majority of nations been able to preserve a distinctive social development, free, however, from any measure of that stagnation which usually follows isolation. Sufficient reasons for this may be found, first, in the high standard of culture which has always characterised the country, and, secondly, in the inherent interest of its people in all things foreign. This trait may have accentuated in some degree the tendency, not unknown in other countries, to over-estimate things of external origin at the expense of home products. On the whole, however, it has not been without value, especially during recent years in connection with the great industrial movement, inasmuch as it has strengthened—without danger of provoking opposition or captious criticism from the more conservative element—the laudable ambition of all classes of manufacturers to avail themselves to the fullest possible extent of the experience and appliances of other countries. As a result, one finds in Swedish workshops the best examples of machinery and machine tools from England, Germany and the United States, and throughout the community a unanimous sentiment that, so far from being regarded as unwelcome, the increased imports under this head should be esteemed high among the evidences of material progress.

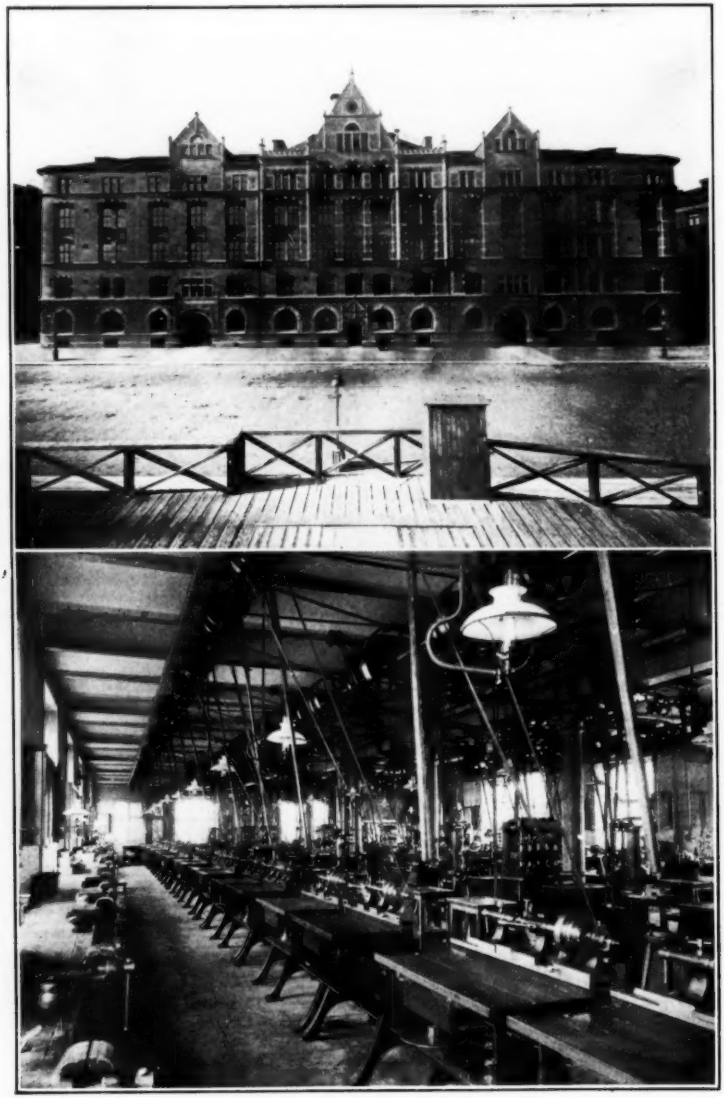
It may perhaps surprise many readers, and even those amongst them who are personally acquainted with the arrangements and output of existing establishments, to learn that it is only within the past fifty years that Sweden has possessed mechanical works and foundries, as we today understand these terms. Such works as existed or were built in the early year of the second half of the last century devoted themselves, in the main, to repairing or furnishing coarser castings for agricultural and factory wants. Then, gradually, in order to give the small staffs regular employment, special manufactures were introduced; but, for a long time, only of such articles as were required in the country, or, in the great majority of cases, in the immediate neighbourhood of the works. Today the outlook is vastly different; compensation for the lack of coal has been found in the ever-increasing use of waterfalls, that other great natural source of power for industrial enterprise; many of the older works have been enlarged and modernized, and to their number have been added scores of establishments, equipped with the most suitable machinery and conducted on the newest and best approved lines, for the exclusive purpose of special manufactures, not only for home but also for foreign consump-

tion. Many of these works have already secured deserved honours at international industrial exhibitions, and not a few are able to point to continuous and increasing activity in regard to external trade.

It is from all points of view fitting that the first establishments of this class to be specifically mentioned should be those which have been founded on Swedish inventions or have been peculiarly active in securing recognition abroad of the Swedes' well-won reputation for technical skill. For machines and implements for dairy work the Scandinavian kingdom has long been pre-eminent. The value of such articles annually manufactured in the country now approaches £600,000, and of this output about seven-eighths is exported. Of the many establishments devoted to the industry, the largest, of course, is that of the Separator Company, Limited, of Stockholm. In its extensive and admirably-equipped workshops and head offices over 1,200 highly-skilled workmen and more than 60 engineers and clerks find employment, and to these should be added the personnel of branches in Germany, Denmark, Austria, Hungary, etc. An important off-shoot, holding the American patent rights in the Alfa-Laval separator and other inventions, is the De Laval Separator Co., of Poughkeepsie and New York. Another works of great interest abroad is that founded on Mr. L. M. Ericsson's many improvements in regard to the telephone and its accessories. Its factory in Stockholm is one of the finest of its kind to be found in any country, employs 1,300 hands, and is a model for equipment and administration.

The manufacture of scientific instruments—surgical, mathematical, physical, chemical and navigation—has attained considerable proportions, is distinguished by a high standard of technical perfection, and offers export figures not unworthy of note. Whereas during the twenty years ended 1880 the annual value of exports under this head averaged but £1,000, it has now risen to about £165,000, an amount equivalent to that spent on similar articles from abroad. In no country probably have magnetic instruments been used so long and with better effect for the discovery of ores and in preliminary exploring work; and in this connection mention may be made of the magnetometer and vertical power balance, constructed by Professor Thalen, of Upsala University, and the Tiberg inclinator. A great economy of shaft and gallery excavations appears to have followed the widespread use of these instruments, and to the same cause may be attributed the excellence of Swedish mine maps and models.

The marked development of the electrical industry during recent years is the result, in large measure, of the nation's enhanced appreciation of the wealth of natural motive power awaiting application in



EXTERIOR AND PART OF INTERIOR OF L. M. ERICSSON & COMPANY'S NEW FACTORY, STOCKHOLM.

its peat-mosses and waterfalls. Of peat-mosses, it has been estimated, Sweden possesses 9,880,000 acres, with an average depth of 6½ feet, capable of yielding not less than 8,000,000,000 tons of peat for fuel, each ton being equivalent in heating power to two tons of coal. On the basis of present prices, and having regard to relative calorific values, machine-made peat at the place of production is about half as dear as coal and 30 per cent cheaper than pine firewood. Its bulk, however, is considerable, which makes it a costly article to transport, and it yields as fuel a large percentage of ashes. To these disadvantages and the ever-increasing recourse to water power must be attributed the comparatively small part which has been played by peat in recent industrial developments.

What, on the other hand, is the industrial value of the energy already utilised or running to waste in Sweden's waterfalls? Calculations necessarily vary, but it seems a conservative estimate to suggest as a fairly approximate figure 4,000,000 horse power. What this implies to Sweden—and, indeed, to countries beyond the Baltic and North Seas—may be gathered from the facts that the entire manufacturing and mining industries of Sweden have at their command today less than 500,000 horse power, and that one horse power, when put to profitable use, represents a capital of £50, or more. Very frequently, of course, the immediate vicinity of a waterfall is unfavourable for the erection of mechanical works, owing to the absence of raw material in the district, great distance from a market for the disposal of the finished articles, or other causes. Most of these objections, however, are today of comparatively small moment, thanks to the practicability of transforming water-power into electrical energy and conveying it in this form over considerable distances. The first important demonstration in Sweden of the value of hydro-electric power was in 1891-2, when energy was transmitted from Avesta, on the Dalelfven, to the Norberg mining region; and since then activity in this field of enterprise has been so continuous that there are now few large industrial establishments—whether connected with agriculture, mining, iron and steel-making, wood-working, or general manufactures—which do not rely upon electricity, wholly or in part, for motive power. At first the machinery and other electrical apparatus were imported from Germany, but the home industry developed so rapidly that it has long since been able to satisfy local requirements and, in addition, to compete successfully abroad with the products of other lands.

The oldest and largest electrical works in Sweden—indeed, in northern Europe—are those at Vesteras, the property of the General Electric Company of Sweden. This corporation, which now has

branches in the principal towns of Sweden and many foreign capitals, secured a considerable advantage over its competitors by its possession of the patents of Jonas Wenstrom, a famous Swedish electrician and co-founder of the three-phase system. Among the most notable plant supplied by it may be mentioned the great rolling-mill motor of 600 horse power at Fagersta, large alternating-current machines delivered to the Marconi Wireless Company, the new generators for the Stockholm electricity works built for a tension of 20,000 volts direct on the armature, power-distribution for many of the leading iron works, and electric hoists, drilling machines and magnetic ore-separators for use in the mines. Among other energetic electrical companies calling for notice are Luth and Rosen, of Stockholm, and the Magnet, of Ludvika.

Each year is adding to the large group of other mechanical works devoting themselves to special manufactures. During 1906, for instance, 761 companies, of which 324 were purely manufacturing and industrial, were formed with an aggregate paid-up capital of £4,278,000, as against in the preceding year 438 companies and £3,319,000 nominal capital. To the establishments of this group, interesting though they are, the exigencies of space forbid more than cursory reference. Restricting myself, accordingly, to firms of comparatively long standing, with annual outputs valued at over £100,000 (several, of course, largely exceed this figure), and employing more than 750 hands, I note the following establishments as fairly typical of the present position of the Swedish machine industry:—

The Atlas works, Stockholm, manufacturing locomotives and other railway and tramway material, steam engines, boilers and compressors, pneumatic tools, conveying plant, etc., employing about 1,000 workmen; the Bergsund works, of Bergsund and Finnboda, both near Stockholm, builders of cruisers, torpedo-boats and other steamers, bridges, and every description of steam plant, number of workmen about 1,400; J. and C. G. Bolinder's works, Stockholm, specialising on wood-working machinery and petroleum motors, about 1,000 hands; Gothenburg mechanical works, steamship, crane and engine builders, about 900 workmen; Carl Holmberg's mechanical works, Lund, manufacturing dairy implements, peat and brick-making machinery, steam engines and castings; the Huskvarna works, employing about 1,200 hands in the manufacture of sewing machines, bicycles, stoves and other cast articles; the Karlstad and Kristinehamm works, manufacturing machinery for pulp and paper mills, turbines, railway material, steam boilers, etc., about 750 hands; the Ludwigsberg works, Stockholm, mining and refrigerating machinery, pumps,

air compressors, fire engines, etc.; Motala works, locomotive and steamship builders, land and marine steam engines and boilers, bridges, pumps, turbines, hydraulic machinery and rolling-mill products; the Munktell works, Eskilstuna, steam engines, boilers and pumps, saw and grinding mills, peat machinery, dredging plant, cranes and machine tools; and Nydquist and Holm, Trollhatte, locomotives, turbines, bridges, water-works machinery, etc., about 900 hands.

A TYPICAL FACTORY. MUNKTELL'S MECHANICAL WORKS, ESKILSTUNA.

No apology need be offered for devoting particular space and attention to Eskilstuna and the so-called "Eskilstuna industry." The town, in the first place, demands notice as the most perfect type of manufacturing centre to be found in Sweden, rivalling, in this regard, even Borås and Norrköping, the principal seats of the textile industry. Its interests are, and have ever been, essentially industrial, and their growth and expansion are in an eminent degree symbolical of the wider movement and national development on which it has been my purpose to centre attention. Even its very origin is an object lesson for today, for there can be no doubt that it was the presence of the powerful waterfalls which serve to unite the great lakes Hjalmaren and Malaren that first led far-sighted men of long ago to believe that here was the ideal location for a purely industrial town. To create this was one of the peaceful ambitions, frustrated by incessant wars,

of King Charles IX (1599-1611). Then the idea slumbered for half a century, until, in 1654, Charles X Gustavus granted to one Reinhold Rademacher, a burgher of Riga, the first of a series of privileges which, it was hoped, would bring about the foundation of "a manufacturing works for iron, steel, copper and brass," to be called "Karl Gustaf Town." The works, however, languished, despite Government support, and, indeed, were confiscated for debt soon after Rademacher's death; and today perhaps the most effective reminder of their former existence is the name Karl Gustaf used to designate the State rifle factory situated on the boundary of the seventeenth-century concession.

TUNAFORS FACTORY, ESKILSTUNA.

In 1771 Eskilstuna was founded as a "free town," the charter providing that everyone who settled within its territory should occupy himself for a livelihood in the working of iron or other metal, enjoy exemption from the capitation tax and customs duties, and have the right of using the urban water-works for a small fee. This arrangement readily adapted itself to the conditions which had prevailed during and since the time of Rademacher, and produced a peculiar manufacturing community, consisting mainly of small householders, each owning also a forge or small workshop. Remains of this old industrial town are to be found in the Eskilstuna of our time, and, as a matter of fact, in modified forms, are the bases of its latter-day prosperity. This may be said to date from the arrival, early in the nineteenth century, of Johan Teofron Munktell, an engineer from the Royal Mint at Stockholm and a pupil of the English mechanic Samuel Owen, who had made his home in Sweden and achieved a reputation

which survives to this day. Munktell established in Eskilstuna a small workshop, which he lived to see develop into one of the largest manufacturing concerns of the country, and played also a conspicuous part in bringing about the application of modern principles to all branches of Sweden's metal industries.

Though, of course, on a very diminutive scale, Eskilstuna can quite aptly be compared to Birmingham, plus Sheffield, in the variety and character of its products. Engaged in what, for want of a better name, has been called the "Eskilstuna industry," there are at present about 55 factories; and of these several, including the largest of all, the Tunafors cutlery works of the Eskilstuna Iron Manufacturing Company, carry on the system familiar to the town since the days of Rademacher. They supply the smaller manufacturers with iron, steel, copper or brass in all suitable forms and dimensions (bars, tubes, plate, etc.) for special requirements, and purchase from the artificers the whole or greater part of the finished products. As survivals, in a transition stage, of old-time industrialism, the small factories are well-deserving of notice, for even the smallest are equipped, more or less completely, with modern machinery, and nearly always with an electric motor. One characteristic, and often very artistic, speciality of the local trade is the method of ornamenting a great variety of products, usually by deep-etching on steel surfaces, often combined with decoration in different coloured enamels, or by ground-etching on copper, brass or silver. This work is performed either by special workmen at the several factories or, in a more wholesale way, by two corporations, the Eskilstuna Metal-etching and Steel-etching Decorating Companies. Closely associated with or outside what may be described as its staple industries, Eskilstuna possesses probably a larger number of manufacturing establishments of the first rank than any town of its size throughout the world. The population, which in 1805 was 1,530, in 1850 3,960, and in 1900 but 13,660, now numbers more than 27,000. For purity and goodness of municipal government, the town enjoys the highest of reputations—even in Sweden, the country *par excellence* of progressive and efficient local administration; everywhere in it one finds evidences of prosperity and healthy competition, and symptoms of an expansion in the near future not less remarkable than that of recent years.

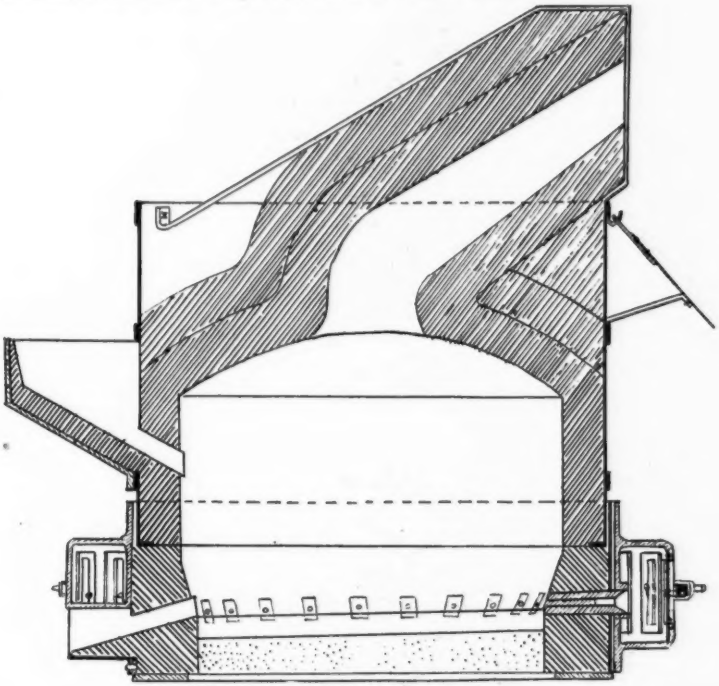
Of peculiar interest are the great iron and steel works, brass forges, etc., which, in addition to special manufactures and the business incidental to mechanical workshops, concentrate much attention on the extraction of metals from the ore and their first refining processes. These, by reason of their size, mechanical equipment, number

DISTRIBUTION OF LEADING IRON WORKS IN SWEDEN.

of employees, necessarily acute administration and variety of output, occupy a position of great importance in Swedish industrial life. Such, to mention but a few, are the great iron works at Domnarfvet, the largest of their kind in northern Europe, employing some 2,500 workmen, and including mechanical works, smelting furnaces, rolling mills, Bessemer and Martin works, etc.; Sandviken, employing about 2,000 men; Bofors, Bjorkborn and Fingspang, notable for guns and war material; Ankersrum, Avesta, Boxholm, Dannemora, Degerfors, Fagersat, Falun, Forsbacka, Hofers, Iggesund, Karmansbo, Kolsva, Lesjöfors, Söderfors and Surahammar. With some of the products of at least two of these, visitors to recent international exhibitions will be already familiar.

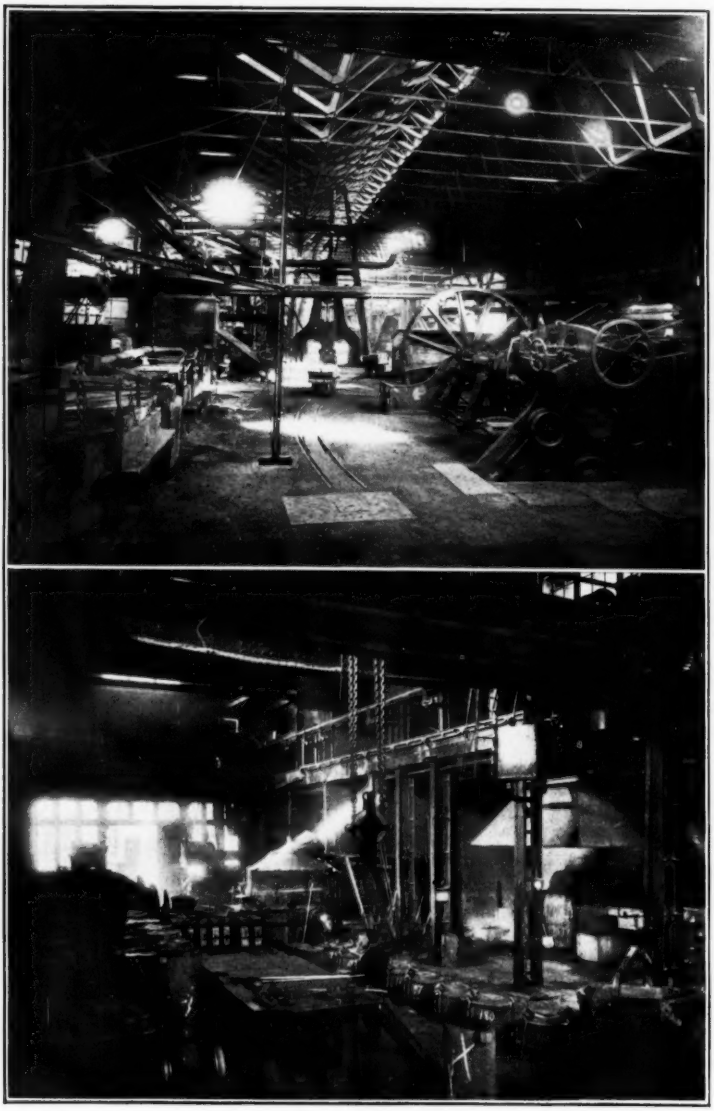
It happened that during the evening following a prolonged visit to the Sandviken works I was present at a banquet which most assuredly merited the definition "unique," inasmuch as it took place many hundreds of feet below the surface and amid the weird surroundings of the ancient workings of the great Kopparbergs mine—once not inaptly called the "Treasury of Sweden." I allude casually to this gathering because it afforded me opportunity to eulogise the very diverse industrial enterprises in which the inheritors of the historic property are now engaged, and the invaluable services of the founder and first manager of the Sandviken works in connection with the revolution in steel making which followed the perfection and widespread adoption of the so-called Bessemer process. Everyone, of course, knows that to Sweden belongs the credit of bringing the experimental stage to a close and of proving, even when Bessemer himself was beginning to despair, that the new process of refining was at once theo-

retically correct, feasible, economical and advantageous. The story of how this came about is so intimately bound up with the foundation of Sandviken that I may refer to a few unfamiliar details.



BESSEMER FURNACE AT EDSKEN, 1858.

At the time when the industrial world was startled by the first announcements of Mr., afterwards Sir Henry, Bessemer's remarkable investigations, there was living in England Pontus Kleman, a Swedish merchant and owner of ironworks at Dormsjö and Garpenberg. Kleman was an enthusiastic believer in the future of the process, and, aided by drawings furnished by Bessemer and a compatriot engineer, named John Leffler, promptly erected at Dormsjö a furnace for the purpose of continuing, on a sufficiently large scale, the English inventor's experiments. The results achieved were far from satisfactory, and of a nature to justify much of the criticism aroused by Bessemer's proposals. They failed, however, to convince Consul G. F. Göransson, then member of a firm of wholesale merchants which owned the Hogbo iron works and Edsken blast furnace. He purchased in 1857 Bessemer's patent for Sweden, and for many months continued ex-



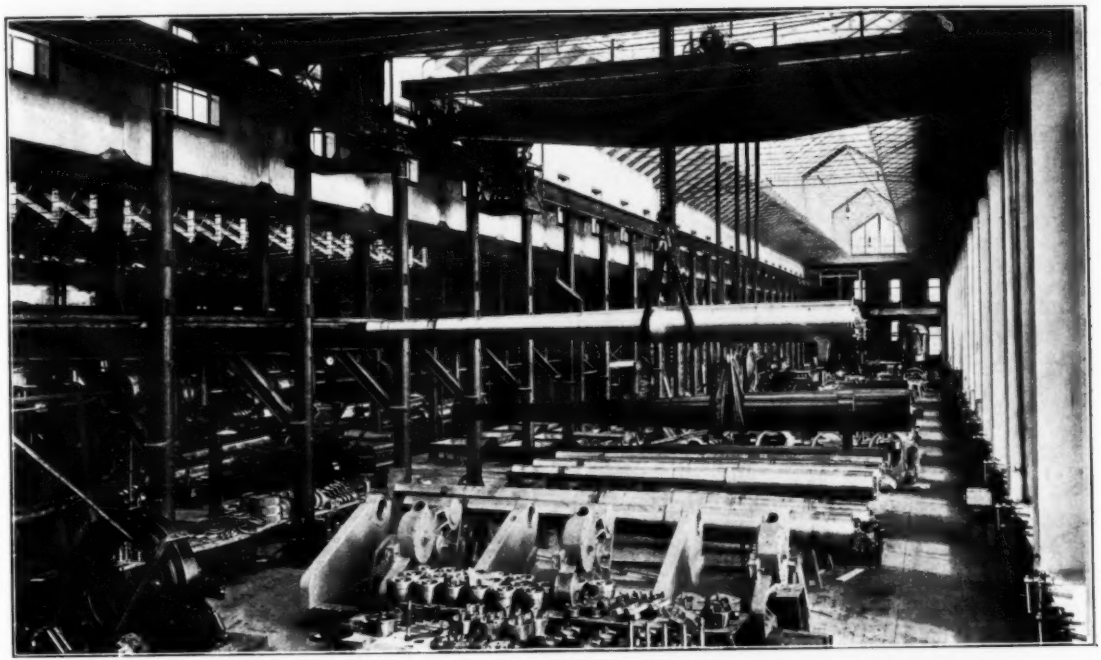
PARTS OF THE SANDVIKEN IRON WORKS.

Above, the forges and tire rolling mill; below, Bessemer converters.

periments at Edsken with variable and inconclusive results. At length, on July 18, 1858, after certain modifications in the furnace, a blowing was made which verified the highest hopes founded on Bessemer's method—the steel flowed easily, was of close grain, could readily be tapped and, in test forging, showed excellent qualities.

PART OF THE SANDVIKEN IRON WORKS.
Band rolling mill, 800 horse power, to the left; tube rolling mill to the right.

The process was continued at Edsken until 1866, and was gradually, in the meanwhile, introduced into other Swedish iron works. Generally, however, owing to the circumstances that the works were small, that the old stationary furnaces were less convenient than converters, and that there were no rolling mills to work down the steel ingots, the advantages expected were not immediately realised. It was to overcome such difficulties that the company was formed, with Göransson as managing director, which in 1862-3 built the nucleus of the present great Sandviken works. Mr. Göransson died in 1900, full of years and honours, and was succeeded by his son, Mr. A. Henrik Göransson. The now largely-extended works provide employment for 2,000 men, and include three blast furnaces, four Bessemer converters, eleven forge rolling mills, complete equipment for cold rolling, tempering and polishing, wire-drawing mills, special shops for the manufacture of saw-blades, spring steel, etc., foundries and great mechanical workshops, all provided with the best shop appliances.



INTERIOR OF GUN SHOP, BOFORS WORKS.

PART OF THE WORKMEN'S VILLAGE, SANDVIKEN.

Power is furnished by 68 boilers and 24 steam engines aggregating 3,800 horse power, eight hydraulic turbines of 700 horse power, and 122 dynamos, the last deriving their electric energy from a waterfall some 30 miles distant from the works. The blast furnaces are fed exclusively with charcoal, their annual consumption being 25,000 tons.

Prominent among the specialities of this works may be mentioned hollow puddled blooms for weldless-tube making, of which Sandviken supplies two-thirds of the Swedish exports; weldless hot-rolled boiler tubes, tyres for railway rolling stock, hammered or hot-rolled steel for files, cutlery and various tools, steel for shells and other projectiles, hollowed wire for umbrella frames, pressed steel, spring steel, steel rods and wire, and cold-rolled steel for such purposes as bicycles, saw blades, and writing pens. The perfection attained in manipulating smaller articles may be gathered from the following data:—

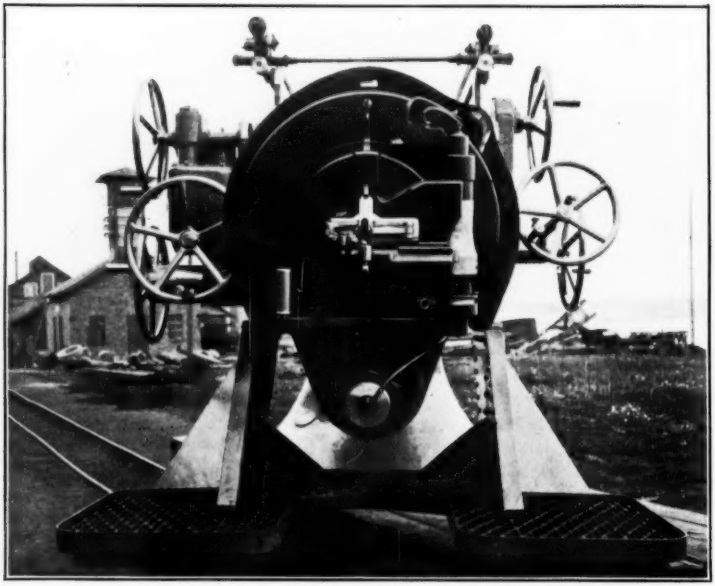
	Length, Yd.	Width, In.	Thickness, In.	Weight, Lb.
Ribbon saw*	65.6	12	.0787	675
do.	26	.17	.08	300
Cold-rolled band steel.....	1145	2.3622	.0011	47.5
do.	760	7.8741	.0177	1105

* This saw, first exhibited at Stockholm, secured grand prizes at Chicago in 1903 and San Francisco in the following year.

RAM AND STERN POST FOR COAST-DEFENSE SHIP, BOFORS IRON AND STEEL WORKS.

NEW MODEL 5.9-INCH GUN, BOFORS WORKS.

By a happy accident, serving to make conspicuous the diversity of the iron and steel interests of Sweden and the technical skill of the men who stand at the head of these industries, the next establishment to be described happens, unlike Sandviken, to have specialised on the heaviest classes of products. Bofors, owing to its position half-way between the Baltic and the Kattegat and in close proximity to the western boundary of the central ore regions, has been identified with the iron industry for at least three centuries; but, needless to say, on a very different scale to that which has made the place famous in modern days. The works of the Bofors-Gullspang Company certainly offer no evidences of antiquity, for most of the departments have either been recently built or reconstructed, and, even at the time of my visit, extensions were still in progress. They at present include three blast furnaces, one Lancashire forge, two open-hearth furnaces with an aggregate capacity of 45 tons, rolling mills for bar and sheet iron, a large building for annealing gun ingots and armour plates, steel foundry, gun shops, etc. For modern equipment, arrangements and methods, the various departments and workshops challenge comparison with those of the largest establishments abroad, and I noted with much interest, distributed over the works and in active operation, cranes, forge presses and a great variety of machine tools, of British and American manufacture. Prominent among the products may be mentioned guns and projectiles, homogeneous rolled or cast oil-tempered armour for cupolas for coast and land defence, and steel castings, such as rudder frames, propellers, anchors, etc., up to 45-tons weight.



BREECH END OF BOFORS 5.9-INCH GUN.

Increasing attention has been devoted during recent years to the manufacture of war material, and so far at least as guns of big calibre are concerned Bofors may be said to enjoy a unique reputation. Elsewhere, all trials with a view to making such guns of cast unwrought steel have resulted in failure, owing, apparently, to difficulty in securing sound ingots of sufficient strength and ductility. At the Bofors works, however, thanks to special methods of casting and annealing, elaborated after long series of experiments, no such trouble is experienced. The ingots are cast solid with large dead heads, but in other respects of about the size intended for the gun. The core is then bored out, the tubular block being subsequently subjected to a series of heat treatments in order to secure the proper physical qualities. Then the gun is built up from various parts in the usual manner. At times, the ingot with the dead head is of the phenomenal length of 60 feet, and I myself witnessed a furnace drawn and a column cast, 50 feet long, for which 14 tons of metal were used, for subsequent conversion into a 9-inch gun. Although guns cast at Bofors have been in service twenty years without showing other defects than usual wear, many ordnance experts, especially in England, continue to regard with undisguised distrust big guns of unwrought steel, pro-

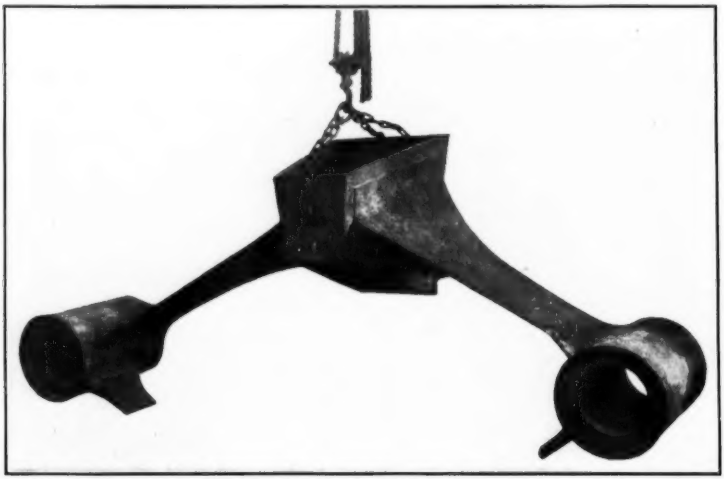
fessing that the tests cannot have been of the most severe character. Against this view, however, the Bofors authorities are able to submit records of the most elaborate tests, and to point to guns from which thousands of rounds have been fired. It is certainly noteworthy that, except in two instances, when high explosive shells have exploded in the bore, there has been no record of the bursting of a Bofors-cast gun, although at times the gas pressure in the bore at firing tests has exceeded 30 tons per square inch. Perhaps, however, the most significant defence (if such be needed) will be found in the facts that Bofors is at present supplying all the big guns required by the Swedish Government, and has provided the three latest Danish ironclads with heavy armament.

The following are details of a gun quite recently completed and tested at the works:—

Calibre	5.9 in.
Length in calibres	50
Weight of gun	7.6 tons
" " charge	33.6 lb.
" " projectile	90.4 lb.
Muzzle velocity	3,065 ft. per sec.
Max. gas pressure	18.2 tons per sq. in.

This weapon varies in some respects as compared with the gun delivered to the United States Artillery in 1901 in connection with tests, in competition with other designs, resulting in the adoption of the Bofors breech mechanism for 6-inch guns. This, also, was 50 calibres in length, but much lighter, weighing only 6 tons, while the projectile, weighing 100 pounds, secured an initial velocity of but 2,800 feet per second. Moreover, the mechanism was semi-automatic, as against fully-automatic in the case of the latest design.

With increased industrial life and its tendency to mass mankind within limited areas, new social problems arise and older ones become more acute. Though Sweden is a large country, sparsely populated, it is no paradox to say that for a considerable and increasing section of its people there is no room to live—in other words, its most pressing difficulty today is the question of housing. The State and municipalities and many semi-philanthropic and other organisations have done something, and attempted more, in the direction of ameliorating conditions arising out of the lack of habitations, with reasonable rents, for the growing army of artisans. So far, however, as the large towns are concerned, the results achieved have been pitifully inadequate. Elsewhere, not a few industrial establishments have found it both necessary and advantageous to build dwellings for their workmen on an extensive scale. In the majority of these cases, the habitations are granted rent-free, but in others endeavours have been made,



SUPPORT FOR PROPELLER SHAFT OF THE CZAR'S YACHT "STANDART." WEIGHT 9 TONS.
Made at the Bofors iron and steel works.

by means of loans, etc., to satisfy the men's natural desire for "own homes." The existence of the problem necessarily came most prominently under my notice in the capital, and it was with particular interest that I studied the conditions at works subsequently visited.

At Sandviken, sufficiently removed from the works to ensure for the artisans and their families pleasant surroundings and a sense of personal freedom, I found a small industrial community of some 6,600 persons, occupying quite a considerable area. Here the majority of the workmen with their families, to the number of about 4,500, live rent-free in 145 houses erected and owned by the company. The latter has also built a church, to the expenses of which it is a liberal subscriber; two hospitals, adequately staffed; five schools, provided with 19 teachers, in which 1,000 children are educated free of charge; club houses and recreation rooms, and a bath house, excellently equipped and of such dimensions that 150 persons can be accommodated at one time with swimming and other baths. Moreover, there exists a self-help society, with a membership of nearly 2,000, which provides grants in cases of sickness or death; a pension fund for aged workers, widows and orphans, and other organisations in which the company takes an intelligent and sympathetic interest. Perhaps, from most points of view, the best feature of all the machinery devised by the company for ensuring the physical and moral well-being of its dependents is the absolute freedom, consistent with ordinary dis-

cipline, enjoyed by all members of the community. Even here, however, I noticed an imperfection, not uncommon in northern Europe, to which I shall later refer.

Among other industrial corporations which have, on a large scale, erected dwellings for their workmen are the Grängesberg Iron-mining, Huskvarna Manufacturing, Bolinder Mechanical, and Rorstrand Pottery Works Companies. The houses built by the first-mentioned are of wood and contain sets of four rooms, each set having a separate entrance. As the rent charged is but 5 shillings monthly, there is naturally keen competition among the married men privileged to become tenants. The Huskvarna Company has not only erected dwellings, which it rents to its employees at from £5 10s. to £8 per annum, but also grants building lots and loans enabling them to build houses of their own, any parts or the whole of which may be sub-let. As the need becomes more pressing, there will, no doubt, be a more general move in the direction indicated, but accompanied, it may be hoped, with larger tendency to increase the room accommodation. Where I found so much to praise, it may seem ungracious to criticise; yet I cannot avoid the conclusion that it is neither logical nor conducive to the best social conditions that the provision for large or small families is normally the same—seldom exceeding three rooms.

In conclusion, a few words may perhaps be permitted in explanation of the inquiries of which these papers are the outcome. It was as a journalist, as the guest of professional *confrères* of Sweden, that I took part in the tour to which allusion has been made. It was no small undertaking, for a comparatively few busy literary men, to arrange and carry through, within the necessarily limited period of the visit, and without visible hitch, such an extensive and diversified programme. Though they no doubt reckoned upon the cooperation of the authorities and the public, they must surely have been surprised, equally with their guests, at the heartiness of the response. From the much-lamented King, Oscar II, his Ministers and provincial representatives down to the humbles wood-cutter in far-away Norrland, everyone conspired to make the tour uniformly pleasurable and interesting, the welcome cordial and national. Individually, perhaps, I have especial cause for expressing appreciation, for, as representing THE ENGINEERING MAGAZINE and peculiarly interested in questions more or less outside the common programme, the most ample opportunities were at all stages granted me, always with extreme kindness and courtesy, for personal study and investigation. My cordial acknowledgements are due to not a few of my hosts, the education authorities and the heads of many large industrial establishments.

THE ECONOMIC ASPECTS OF WOOD PRESERVATION FOR STRUCTURAL PURPOSES.

*By Carlile P. Winslow.**

The following discussion of the preservative treatment of structural timber is in striking contrast to the majority of publications on the subject. In the voluminous body of literature which has already appeared, the technical details of preservative processes have received most ample treatment, but little information is to be found on the economic aspects of the problem. Mr. Winslow's article has, therefore, a peculiar interest, in that he gives many definite practical data on the costs and economic results of the practice as applied to a variety of types of engineering structures.—THE EDITORS.

PRESERVATION of wood against decay by treatment with chemicals has, until late years, received but scant attention in the United States, and even at the present time the consumers of wood for structural purposes give far less attention to this question than its importance justifies. The supply of the better grade of timber, which through its own properties resists decay for a reasonable time, has been so plentiful and the initial cost so small, that timber with less favorable properties has been practically disregarded. Now, however, the supply of the superior grades of timber is rapidly waning, prices are rising despite the indications offered by the present temporary setback, and the difficulty of obtaining the best timber at a reasonable price is rapidly increasing. Lumber dealers, on the one hand; railroad managers, mine superintendents, and other consumers of timber for structural purposes, on the other—are finally awakening to this fact, and are gradually turning their attention to ways and means of substituting cheaper and more plentiful kinds of timber for the more expensive and superior grades.

Owing to the rapid growth of the country, its advance in industrial and manufacturing lines, and the many and varied uses to which wood is put, the amount of the annual cut of timber is almost inconceivable. It has been estimated that, in 1906, approximately 40 billion feet, board measure, of lumber, 11 billion shingles, 100 million railroad ties, 4 million poles, 20 million fence posts, 170 million cubic feet of round mining timbers, 3 million cords of pulpwood, 1½ million cords of tanbark, and about 100 million cords of firewood were cut, which, together with the quantity used for miscellaneous pur-

* Expert, Office of Wood Preservation, Forest Service.

poses, gives a total of approximately 40 billion cubic feet. The Forest Service has computed that this figure exceeds about three times the annual growth on the forests of the country, and it is therefore evident that unless some radical change be made a serious shortage of structural timber is inevitable. This is especially true of the hardwoods. The region of supply of this class of timber is limited since none is found in the western States. When the supply in the East, and more especially in the Appalachian district, is exhausted, many important industries, which demand hardwood for their products, will be severely handicapped.

A feasible and effective method of relieving this situation is by the chemical treatment of the timber to protect it against decay. A successful treatment of this sort, provided the cost be kept within economical limits, will not only in the long run greatly decrease the cost to the consumer, but also will tend to reduce the annual demand for timber. When wood preservation was first introduced in America, the great drawbacks to its extensive adoption were the expense of the treatment and necessary apparatus, and the lack of reliable information regarding the results. Now, however, methods have been devised whereby the treatment may be carried out on an economical basis; scientific investigation has determined just what kind of treatment is best suited to the different classes of woods and to the different conditions under which they are to be used; and reliable figures have been obtained regarding the actual increase of life obtained from various treatments. As a result, a new and increasing market has been created for many timbers not formerly used; timber consumers are gradually breaking away from their former custom of adhering closely to a few well-known kinds of timber, with a consequent general disregard of others because of a belief based largely on tradition or prejudice and not on actual disqualifications; and there is an increasing realization that by the use of cheaper woods properly treated with preservatives, as good or better results can be obtained, together with a reduction of the annual costs. This last item, the saving in dollars and cents, is the all-important feature in the future of wood preservation. As soon as the customer fully understands that his annual expenses can be actually reduced by these methods, it is only natural to conclude that a strong effort will be made for their adoption.

It has already been demonstrated that the life of timbers in many situations has been increased at least twofold by the use of preservatives, and often the increased life is very much greater. Suppose, for

example, that certain timbers put to a certain use will last five years without treatment. Disregarding interest charges, it is then evident that in order to effect a saving, the cost of treatment must be less than the additional cost of new timbers five years later, plus the cost of their setting. In treating on a large scale the additional cost will in most cases not exceed the present purchase price of the timber; therefore the saving secured will be, at the least, the cost of resetting the timbers, plus the advance in the price of the timber over a period of five years. For example, the popular grade of mining timbers in the West has increased some 40 to 50 per cent in price within the last five years, and it is reasonable to suppose that a corresponding if not greater increase will occur within the next five years. Therefore, the corresponding financial saving from treatment will be equal to the cost of placement (naturally a variable quantity) plus 50 per cent of the present cost of the timber. This figure will be very materially increased by a treatment which will triple or quadruple the life, and this can be obtained at a cost that does not very greatly exceed that which gives the double length of life. Another factor entering into the economic value of the treatment is that often the replacement of timber is an expensive undertaking, entailing the shutting down of the work in hand during the period of replacement, with a consequent more or less serious financial loss. For instance, the replacement of the timbering in a permanent mine shaft will often partially, if not wholly, stop all work through that section during the period of replacement, with a corresponding financial loss to the company. Since by treatment these replacements may be easily reduced by one-half, and often to a greater extent, it can be seen that this element bears an important relation to the financial saving accruing to preservative treatments.

The advisability of artificial preservation, as well as the kind of preservative and the process, depends upon the structural characteristics of the timber and the particular conditions under which it is to be set. Practically all trees in the United States form two distinct classes of wood during their growth—namely, the outer zone or sapwood, which is the live or growing portion of the tree; and the inner zone or heartwood, generally of a more compact or dense texture than the sapwood, and consequently more difficult to impregnate with a preservative. It is therefore evident that those species containing a large percentage of porous sapwood are best adapted for treatment, for, other things being equal, the success of any treatment depends fundamentally upon the penetration secured. By a comparative

study of the salient characteristics of various woods, some idea as to their respective decay-resisting qualities and the benefit to be derived from a preservative treatment may be formed, but only by actual experience can definite knowledge be obtained. From long years of usage it is now generally conceded that osage orange, red cedar, black locust, redwood, cypress, white cedar, catalpa, black walnut, post oak, white oak, and chestnut, are prominent among the species which stand up well against decay; and, where available, they have been used for a great variety of purposes where inferior species could have been made to do as well. It is important to realize that the more prevalent of these woods, white oak and cedar, are rapidly being consumed; that others, osage orange and black locust, are difficult to obtain; and that it is essential that the supply of these timbers be carefully handled and used only for purposes where substitution of inferior grades is impossible.

A wide field for the betterment of these conditions exists in the more general introduction of preservative treatment with reference to railroad ties. During the year 1906 approximately 103,000,000 ties were purchased, the majority of these being oak, cedar, and chestnut. Formerly, oak was the most popular and widely used species for this purpose, but in the past ten years the cost of an oak tie has more than doubled and the railroads have consequently been turning their attention to other species. Thus, loblolly pine in the South; hemlock and tamarack in the Lake States; lodgepole pine and Engelmann spruce in the West; birch in Wisconsin and the New England region; and maple and beech in Michigan, Pennsylvania, New York, and Vermont, are gradually attaining recognition and are found when properly protected from decay and mechanical wear to give satisfactory results. For example, it has been estimated by the Chicago & Northwestern Railroad Co. that the cost of the average untreated hemlock or tamarack crosstie when laid for use west of the Mississippi, is about $0.75. The cost of a satisfactory impregnation with zinc chloride is about $0.12 per tie, making the cost of the treated tie $0.87. On the basis of an annual charge computed from the formula

$$a = p \frac{(1+r)^n r}{(1+r)^n - 1}$$

in which a is the annual charge, p the initial expenditure, r the rate of interest expressed decimally and n the years of the recurring period, the following comparative statistics are derived, using as the basic data the estimated life of an untreated tie as 5 years, and an interest rate of

4 per cent. Then the annual charge on an untreated tie costing 75 cents is 16.8 cents. For a treated tie costing 87 cents and lasting 6 years the annual charge is 16.6 cents; lasting 7 years, is 14.5 cents; lasting 8 years, is 12.8 cents, and 10 years, the estimated life of a treated tie, is 10.7 cents. These figures demonstrate that an added life of a single year makes the cost of treatment practicable, and an added life of 5 years (a conservative estimate) secures a saving of 36.3 per cent in the annual charge. By the substitution of a creosote for the zinc-chloride treatment, although at some increase of the initial cost, the tie can be conservatively counted upon to resist decay for 20 years, and this added length of life will amply repay the extra cost of the treatment.

But in considering the maximum life to be obtained from a tie the mechanical wear upon it is an important factor. It is of no use to preserve a tie chemically to resist decay for from 20 to 30 years when its mechanical life will be less than one-half as great. The use of tie plates and some form of screw spike in substitution for the present "barbarous" cut spike has been successfully adopted in Europe, but has received scant attention in America. By the more general use of such means for prolonging the mechanical life, combined with a treatment to preserve against decay, the maximum efficiency of a tie will be obtained.

The vast number of poles annually used for telephone, telegraph, and electric power lines has also an important bearing upon the development of wood preservation. During the year 1906, 3,574,666 poles were purchased, with an average value per pole of $2.65 at the point of purchase. Although no figures have yet been obtained as to the number used during the past year, it was undoubtedly much larger than that quoted for 1906. Of these, nearly nine-tenths were cedar and chestnut, cedar forming about three-fifths and chestnut over one-fourth. The region of supply of these species is very limited, cedar being obtained almost entirely from the Lake States, while chestnut is chiefly confined to parts of Pennsylvania, Maryland, Virginia, and West Virginia. The cost of transportation is consequently apt to be very great, often more than equaling the initial cost at the point of purchase. This then, coupled with the facts that the available supply of these poles is rapidly diminishing, with a consequent increase in cost, and that practically all untreated poles must be renewed within 15 years, makes it of paramount importance that some other class of timber be substituted and something be done to prolong their life. In the southern States the pines are very prevalent, and most

species possess all the necessary structural requirements for poles with the single exception of their inability to resist decay. By a thorough treatment with creosote this drawback may be overcome. For example, let us consider the loblolly or old-field pine. The cost of a 30 or 35-foot pole of this species, including hauling and setting, may be assumed as approximately $5, in its region of growth, while its natural life will probably not exceed 5 years. Considering the interest on the investment as compounding at 5 per cent, the annual charge is found to be $1.15. A pole of this sort may be given a satisfactory butt treatment with creosote for approximately $1.00, and, unless set in a very unfavorable condition, a service of 20 years may thereby be expected. The annual charge on the treated pole, then, with the same rate of compound interest, is only $0.48. Thus, an annual saving of $0.67 per pole is obtained by the treatment, and if the yearly increasing cost of a pole be considered, this saving will be considerably increased. So also in the far western States it has been found that the yellow or "bull" pine of that region may be successfully treated with a preservative at a cost not exceeding $2.50 per pole and its natural life of two years thereby increased fully ten times.

Other opportunities for the introduction of so-called "inferior" grades of timber for pole usage exist in the great stand of fire-killed timber in the Rocky Mountain district. Prominent in this class are the lodgepole pine and Engelmann spruce. Owing to the general but erroneous belief that fire-killed timber is unfit for structural purposes, the demand for these two species has been small and the initial cost consequently low. By actual tests, however, it has been found that sound fire-killed timber is often twice as strong as freshly cut green timber of the same species, and when preserved against decay can be very advantageously used for poles, posts, mine timbers, and other structural purposes. In view of the present low cost of fire-killed Engelmann spruce and lodgepole pine, these species can be given a thorough preservative treatment, and the initial cost be kept well within economic limits.

The annual demand for timber for use in mines has reached vast proportions. In 1906 the round timbers alone used for this purpose amounted to approximately 170,000,000 cubic feet, but owing to the great quantity of square timbers also used the total figure is considerably larger. Much of this it would not be advantageous to treat with preservatives, as current mining practice is such that a large percentage of the timber serves its purpose in a short time and is then

lost; as in the long-wall system in coal mining and, in metal mines, in the stulls in prospect raising, and timber set in stopes. But it has been estimated that approximately from 40 to 50 per cent fails from decay, and on account of the great increase in price of mine timbers during the past ten years, it is of great importance to the mining industry that something be done to correct this extravagant waste. The average life of mine timbers set for permanent use can be considered as not more than three years. Douglas fir and western yellow pine, two of the most widely used species for this purpose in the West, cost, where they grow, approximately $14 or $15 per thousand feet board measure and this price is continually rising. A thorough preservative treatment with creosote can undoubtedly be obtained at a cost not to exceed $20 per thousand feet board measure; fairly good treatment which will increase the length of service to at least ten years will cost about $15 to $16 per thousand feet board measure. These figures are of necessity only approximations, since the condition of the timber, method of treating, and quantity and quality of preservative injected are the determining factors in the cost. But the economic value can not be doubted, for assuming a combination of the worst conditions (high cost of treatment—$20 per thousand; and short service—nine years) the saving per thousand feet is found to be approximately $10, or slightly over $1 per year.

The application of a chemical preservative to timbers for use in piling and bridge construction is also an important factor in the development of wood preservation. Mr. A. F. Robinson in a report at the recent meeting of the American Railway Engineers and Maintenance of Way Association, says:

"At the present market prices, pile bridges built of untreated softwoods and designed for the heavy rolling loads used, will cost from $8 to $14 per linear foot. For bridges with piles, caps, and sway braces creosoted, (other parts untreated), and no freight haul over local line included, the cost will vary from $10 to $15 per linear foot. Because of the comparatively restricted areas in which acceptable softwoods are obtained, the great demand and long freight haul, there is little probability of these timbers ever costing much less than at present." Hence, a satisfactory treatment will increase the cost of the bridge from $1 to $2 per linear foot. It is estimated that the life of untreated bridge timbers varies from ten to sixteen years, while well creosoted piling will give approximately thirty years service. Thus at a maximum cost of treatment of only one-fifth the initial cost of the bridge, it can be made to give from two to three

times the service it will yield when untreated. But it is essential for the successful treatment of piling that a preservative which is insoluble in water be used, and in large quantities; where the piles are to be placed in salt water, a preservative of strong antiseptic qualities is the only effective kind. Otherwise the "*Xylotrya*" and "*Teredo*," the two most common marine wood borers, more commonly known as "ship worms," will attack the piles with very detrimental results. Since a deep and thorough penetration of the preservative is not only desirable but essential, the woods with relatively high absorbing qualities should so far as possible be chosen. Thus, the pines on the Gulf of Mexico and Atlantic coast give very good results when properly treated.

The use of treated timber in heavy building construction is also growing in favor. In the low, moist portions of New Orleans sanitary floors have long been in use and have given satisfactory results. The heavy sleepers upon which the floor is laid are impregnated with creosote. Besides being rendered very resistant to decay, the floors are sanitary and resist the growth of pathogenic organisms. Boardwalks and railway platforms can also be successfully treated. Large amounts of timber are annually used in such construction, and no other material has been found to meet these exacting requirements. In the construction of roofs, especially those subjected to damp vapors (as in certain pulp works) treated timbers can be successfully and economically employed. In fact, timber preservation will prove economical in all construction where the wood is placed in damp, warm, ill-ventilated situations and in which timber is costly or difficult to replace. The resistance of wood to the transmisison of heat makes it a particularly valuable structural material for buildings, and especially is this true for greenhouse construction and for shingles. Mixed with stain, shingles can be creosoted by the open-tank process at a cost of less than one dollar per thousand. This permits attractive, economical and durable construction.

As a final example of the future field for wood preservation, together with its bearing upon the more general use of wood for structural purposes, the introduction of creosoted wood-paving blocks may be considered. The natural properties of wood, such as low traction resistance and freedom from dust, have led to many attempts for the utilization of untreated blocks in the past, but no very satisfactory results were obtained. If thoroughly seasoned before placement, moisture was rapidly reabsorbed; if placed in an unseasoned condition, moisture was evidently present at the start. In either case

decay soon set in, the maximum efficiency was lost, and the maintenance charges for repairs and replacements consequently exceeded economic limits. But by a thorough treatment with creosotes, it seems probable that these difficulties may be overcome. Certainly a creosoted block will better resist decay than an untreated one, and the creosote present will act against the absorption of moisture and thus tend to produce the maximum mechanical efficiency of the block. The initial cost of this class of pavement, however, is a serious drawback to its wider use. An average of the costs, taken from ten cities in which it has been used, gives $3.10 per square yard when laid, no allowance being made for excavation and curbing. Whether or not this high initial cost will be repaid by the length of service obtained, can not be definitely stated, since no such pavements have been laid in the United States for a sufficient period to give accurate results. The best example at present is the Rush Street Bridge in Chicago, Illinois, which was paved with creosoted longleaf pine in 1899, and the blocks are still in good condition and give prospects of several more years service. That longleaf pine was used not only in this bridge, but practically for all paving blocks formerly placed, goes to prove the afore-mentioned tendency to adhere to popular grades of timber. There is no reason to believe that Douglas fir, western larch, white birch, and hemlock, when properly treated, will not give satisfactory results, and test pavements of these species have been laid in Minneapolis, Minnesota.

In the scope of this article, only a few of the more striking and important fields for the development of wood preservation can be cited, but there are many other opportunities for the successful introduction of preservative methods. In general, wherever timbers are to be placed for permanent use, under conditions favorable to decay, or where a subsequent replacement would entail heavy charges, a thorough treatment of the best quality is recommended. Oftentimes, when a company is using large quantities of timber, the establishment of a treating plant will well repay the cost of the investment.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review of Continental locomotive design, steam practice, shop methods, and mechanical devices began in our issue for June. His first instalment dealt with the practice and product of German works; his second, with recent advances in Switzerland and France, and the utility of the new welding processes in the work of railway shops. This third and concluding section covers, principally, the newest Italian locomotives, and, with less detail, the most recent types introduced on the railways of Roumania, Denmark, Belgium, Hungary, and Russia.—THE EDITORS.

THE change of control in the Italian railways, which are now operated by the State, has had the effect of standardising locomotive types and has resulted in the ordering of great numbers of engines and cars of the value of 155 million lire, of which 33 millions are for locomotives so far ordered this year. About half the value of the orders has gone abroad—principally to Prussia—the home firms not being able to quote such low prices or to deliver so early. All of these, except for an insignificant number, are two- and four-cylinder compounds. This is the outcome of years of extended experience with these systems. It is a fact that after a hard and rough service of 15 years—and that with indifferent care as compared with newer engines—a two-cylinder compound will show a yearly saving of 14 per cent in fuel cost as compared with engines identical in number of parts, of the same type, same weight, same steam-pressure, same service, but only differing in having unequal instead of equal-sized cylinders. Such a result cannot be realised by any arrangement at once so simple and thoroughly practical. Nor are there of necessity any inventor's fees to reduce the full value of the economy obtained. This 14 per cent is an average economy for two-cylinder compounds in various countries where the necessary acumen has been employed in their design. Little though the designer, in his short passage through the offices of a certain company, may suspect the result of his work, it may be mentioned here that such results are obtained this day in 1908, from the engines designed in 1891-2 by M. Edouard Sauvage, of literary repute. The decision in Italy to build large numbers of two-cylinder compound is therefore amply justified by results. The cost of upkeep is also less with such compound engines, not only

as the result of the lessened consumption of fuel in the firebox, but by reason of the more evenly distributed efforts on the pins and journals due to the later cut-off of the valves, whereby the maximum piston efforts are low in proportion to the average, through one revolution, as compared with single-expansion engines in which the piston effort at the beginning of the stroke is high in proportion to the average driving effort. Where two-cylinder compounds are booked for general repairs with a whole series of single-expansion engines of the same class it is difficult to estimate the value of the mechanical saving, but the late Prof. von Borries, formerly of the Prussian State Railways, gave the averages of 9 to 11 years working as follows: average mileage between repairs, two-cylinder single-expansion engines = 2,300 miles; between repairs, two-cylinder compound, = 2,920 miles.

The new Italian compounds of this type are built with inside and also outside cylinders. In all cases the cylindrical valves are placed outside of the frames.

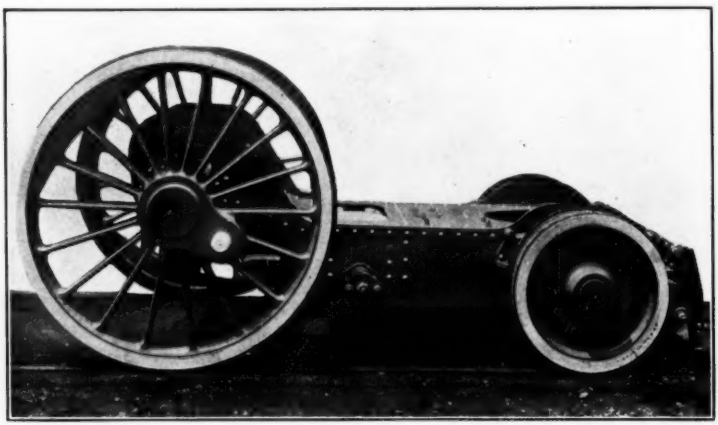


FIG. 28.* ZARA TRUCK FOR 0 OOO 0 LOCOMOTIVES.

In four-cylinder compounds the most notable change has been, for express engines, the supplanting of the four-wheel pilot truck by a two-wheeled pony. The former trucks weigh, in the "Adriatic" *oo OOO* engines, 5,805 kilogrammes and the latter, in the *o OOO o* engines, only 2,885 kilogrammes. The saving in weight is of much importance on railways where the wheel load permissible is under 15 tons per pair. The new truck is an adaptation of the Krauss-Helmholtz (Munich) which borrows one of the driving-wheel axles as the

* The figure numbers are consecutive with those in Mr. King's two preceding articles.

second axle to combine as a four-wheeled truck, but with a fixed and rigid center pivot to the frame. In the Italian modification the center pivot is supported by swinging links permitting a radial movement to the whole frame on its oscillating center. This improvement renders the truck safe for speeds of 70 miles per hour on roads abounding in curves and as compared with 40 miles on the Krauss truck. The illustration, Figure 28, of this truck is self-explanatory. It is used for all six-connected passenger engines in Italy—four-connected engines being now obsolete practice. In the Tellina Vale and Simplon electromotors, all of *o OOO o* type, one truck is placed at each end of the locomotor frame. The designer of the truck also introduced the oscillating axle box cheeks that are now applied to every axle in passenger locomotives in Italy—see Figure 29. The object of these oscillating liners is to enable axles, when on curves, to depart freely from their normal parallelism in respect to the transverse alinement of the frames and as caused by the super-compression of the springs due to the super-elevation of the outer rail and to the centrifugal force, at high speed, acting against the outer rail. Ordinary axle boxes tend to maintain the axle parallel with the transverse line of the frames and with the tendency to strain the axle-box guides and frames, as also to cause undue pressure at one extremity or the other of the journal and brass. Plate frames have frequently been broken in service on short-radius curves, the break being attributable to this action, which is completely avoided in these oscillating axle boxes.

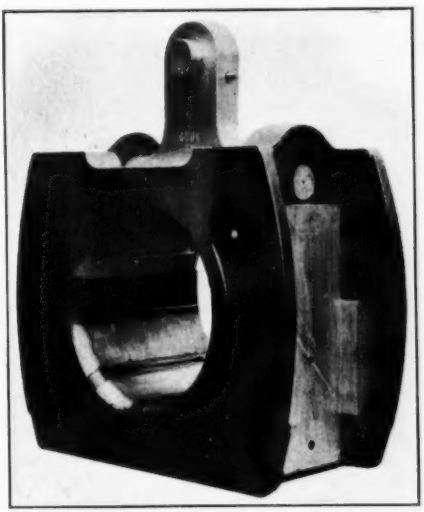


FIG. 29. ZARA OSCILLATING AXLE BOX.

Another improvement by Giuseppe Zara, designer of the new Italian locomotives and of the electromotor trucks of the Italian railways, is the tri-phasic action throttle valve shown in Figure 30. It is really a safety device to prevent the ordinary equilibrated throttle

valve from opening of itself, or by accident. To avoid such possibility it is usual to fit the throttle handle with a latch as shown in Figure 7, in June. Briefly explained, the throttle is fitted with a pilot valve, which may be inside the main valve or fitted outside of the steam pipe, the opening of which requires but little effort. Closed, the whole pressure of the steam holds the main valve down to its seat, but the pilot valve admits steam below a loosely fitting cylindrical portion of the main valve, and then part of the steam relieves the pressure on the main valve and part of it passes around the outside of the cylindrical valve and escapes to the cylinders so commencing the first period of pressure on the pistons; at this moment the drop-seat valve at the head of the throttle is lifted from its coned seating and the second period of pressure is begun; the sectional area of the opening continues to increase with the lift until the drop valve is clear of the valve chamber, then the third period of full pressure is entered. The effect of the arrangement is said to be to increase the pressure on the pistons gradually and to diminish slipping of the wheels in starting and risk of undue strains on the motion gear. For four-cylinder compound engines it is usual to admit steam automatically to the low-pressure cylinders during the first revolution of the wheels. This is done by means of the small pipe, shown in Figure 30, connecting the lowest part of the throttle valve chamber with the low-pressure cylinder valve chests. In these latter a simple device on the valve stem prevents the passage of this steam into the receiver except when the valves have full travel, as is only the case when starting.

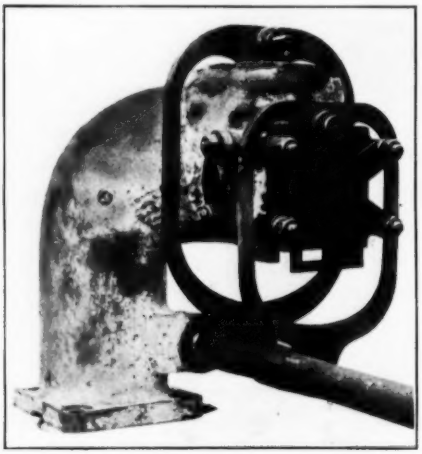


FIG. 30. ZARA THREE-PHASE THROTTLE COMBINED WITH BYE-PASS.

Flat valve for direct steam admission to low-pressure cylinders.

The cylinders of the four-cylinder engine now built and building in such large numbers for Italian railways differ from the cylinders

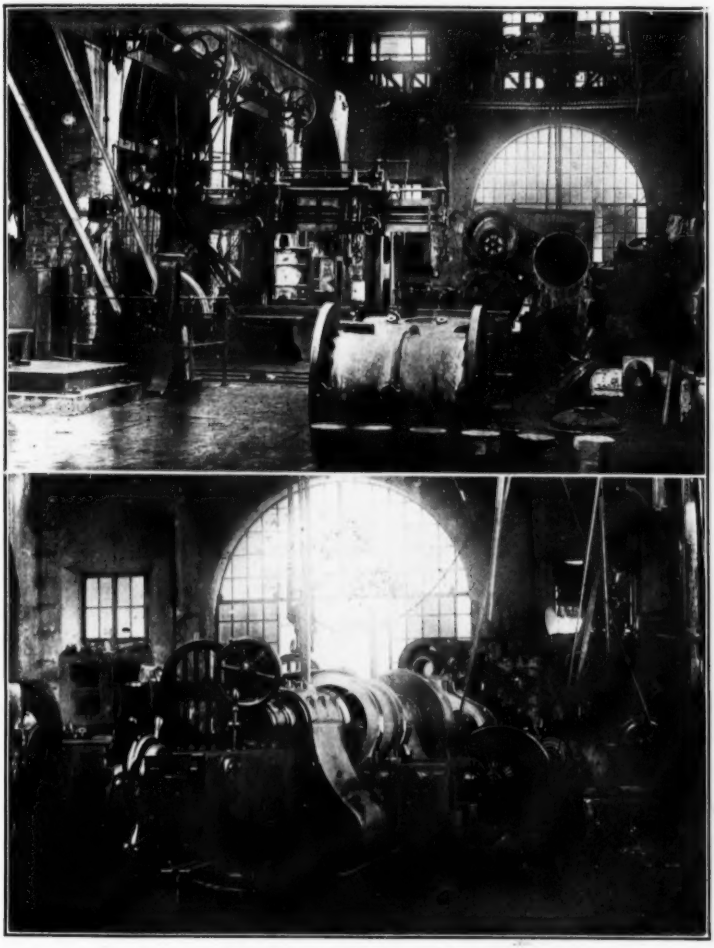


FIG. 32. MILLING MACHINE FOR LARGE CYLINDERS.
FIG. 31. ROUGH-BORING CYLINDERS ON NILES BORER.

employed anywhere else in the world. There are four cylinders, but the valves are only two in number just as usual in the most ordinary two-cylinder engine. Relatively to the number of cylinders, the Italian arrangement is therefore simpler than engines which require one valve for every cylinder. Here, one valve suffices for two. The engine is, effectively, a double two-cylinder compound—the cylinders

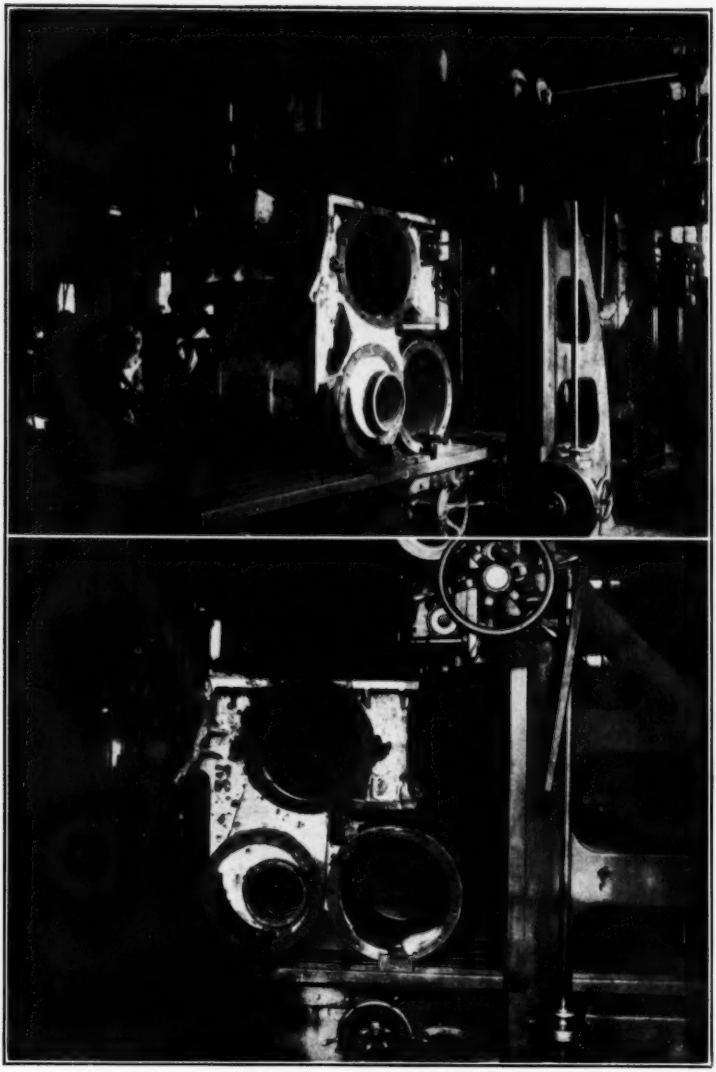


FIG. 33. MILLING ENDS OF CYLINDER FLANGES.
FIG. 34. MILLING UNDER SIDE OF CYLINDER FLANGES.

remaining with the same disposition as in the original two-cylinder compound arrangement introduced by M. Anatole Mallet in 1876, but twinned—with two high-pressure on one side and two low-pressure on the other—an arrangement that has given the very best of results in service, there being no compound engines which run with greater regularity of movement. At the time of writing, 88 engines are in construction with these cylinders, of which 12 are at Maffei's. The machining of these pieces is interesting by reason of the size of the whole group when bolted together—close to the center line. The process of working as carried out in the Ernesto Breda Locomotive Works of Milano, Italy, is shown in the accompanying views. The cylinders are rough-bored for detecting any defect which would at once condemn the casting. A double-headed cylinder borer by the

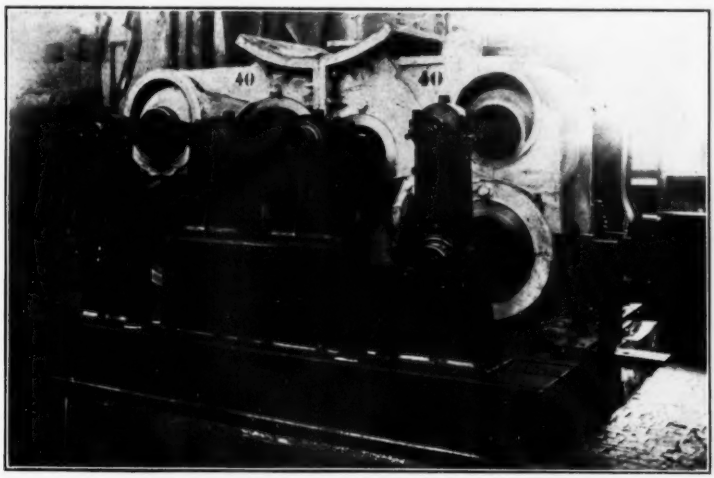


FIG. 35. SIX-SPINDLE CYLINDER BORER AT WORK.

Niles Tool Works, Figure 31, is employed for this work and the castings are then passed on to the large double-spindle milling machine by Guller & Zust of Intra, Lago Maggiore, Figure 32, which machines the central joints for the bolting together of the two castings. This machine does face and edge milling. Figure 33 shows both spindles engaged in edge milling the ends of the central lugs, and Figure 34, milling the underside of the same joint with the casting simply run forward on the carriage. The cylinders are then bolted together and accurately bored, all four cylinders and two valves simultaneously, on the six-spindle horizontal boring machine shown in the view

Figure 35. This is a new machine designed and constructed specially for the work by the Ernesto Breda Locomotive Co. with the co-operation of the noted Italian tool-makers Guller & Zust of Lago di Maggiore. The machining done by it has the accuracy of jigged work. The illustration will serve all purposes of written description.

The cylinder castings are made in the works' foundry and on account of the crossed ports in the high-pressure group some little skill has to be exercised. Expressed in kilogrammes per square millimetre the tensile strength of the metal is 18 to 24 kilogrammes and it is submitted to special shock tests. The port edges are milled and rounded. Valve-chest liners, of cast iron, are forced in place by hydraulic pressure—a practice not approved by some makers and repairers. The domed valve-chest covers are, of course, steel castings —the rest, cast iron. The high-pressure group when complete is tested by water pressure of 20 kilogrammes per square centimetre; the low-pressure group to 10 kilogrammes per square centimetre. The entire cylinder battery weighs 7,245 kilogrammes.

The pistons, in the newest engines, are of forged iron of 44-49 kilogrammes strength and 15-25 per cent elongation. Gisholt lathes, Figure 36, are much used for this repetition work. The piston valves are steel castings of 44-49 kilogrammes strength with 15-25 per cent elongation. Elastic segments for valves and rings for pistons are of cast iron. The piston rods are of hard forged steel of 65 kilogrammes strength and 12 per cent elongation set on the pistons under pressure. Crossheads and crosshead guide bars of forged steel have the same tenacity and elongation. Guide-bar milling is done on a battery of Ingersoll Milling Machine Co.'s tools—Figure 37. The nearest of the machines has the electromotor mounted on the main milling spindle. Slippers for crossheads are steel castings of 44-49 kilogrammes tenacity and 15-25 per cent elongation. They are lined with white metal: 83 per cent tin, 6 per cent copper, 11 per cent antimony. Crosshead pins of iron have 37-44 kilogrammes tenacity and 20 per cent elongation. The main driving and side coupling rods —see Figure 38—are of mild forged steel, 45-55 kilogrammes tenacity and at least 22 per cent elongation. The outside main rods weigh 267 kilogrammes and the inside main rods 339 kilogrammes. All rods of the valve mechanism are of forged mild steel, 44-55 kilogrammes tenacity, 22 per cent minimum elongation, the eyes of all rods and levers being bushed with hardened steel set in with hydraulic pressure. The expansion links, of 37 to 44 kilogrammes tenacity and 22 per cent elongation, are hardened on their wearing surfaces.

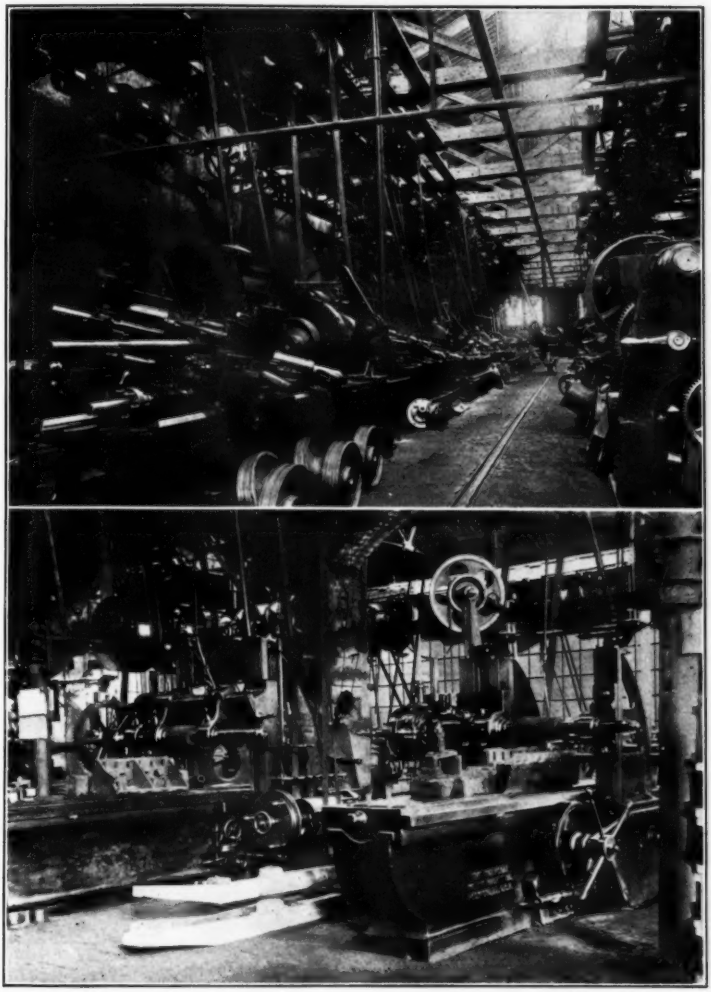


FIG. 36. GISHOLT LATHES WORKING ON PISTONS AND CYLINDER COVERS.
FIG. 37. MILLING GUIDE BARS ON A BATTERY OF INGERSOLL MILLING TOOLS.

The boilers of the four-cylinder compound engines are designed for a working pressure of 16 kilogrammes = 215 pounds per square inch, and formed of homogeneous iron—mild steel—plates, 18½ millimetres thick in the barrel and 22 millimetres thick in the round-

topped firebox, the tenacity being from 34 to 42 kilogrammes with 27 per cent elongation. For all flanged work, throat sheet, back plate and smokebox flue plate etc, Breda's employ the hydraulic press with steam intensifier shown in Figure 39. This steam-hammer type of press was made exclusively for the firm by Haniel & Luig of Düsseldorf and is highly prized, for its handiness. It bends the whole contour of the plate to be flanged at one pressure, and to the required size, by the use of suitable dies and templates. The plate to flange is placed on the lower convex die and the upper concave die is then lowered so far that the concave die rests on the plate under a pressure of 700 pounds per square inch. The piston rod of the steam pressure transmitter then enters into the cylinder of the hydraulic ram and the pressing continues under tensions of from 4,200 to 7,000 pounds per square inch. For pressing out the openings for fireholes and other large holes a special hydraulic cylinder is mounted on the lower press table, and operates in ascending. In this space it is scarcely possible to describe the press further. It is made for pressures of 300 metric tons; has a reach of 4 feet, a single stroke of 4 inches,

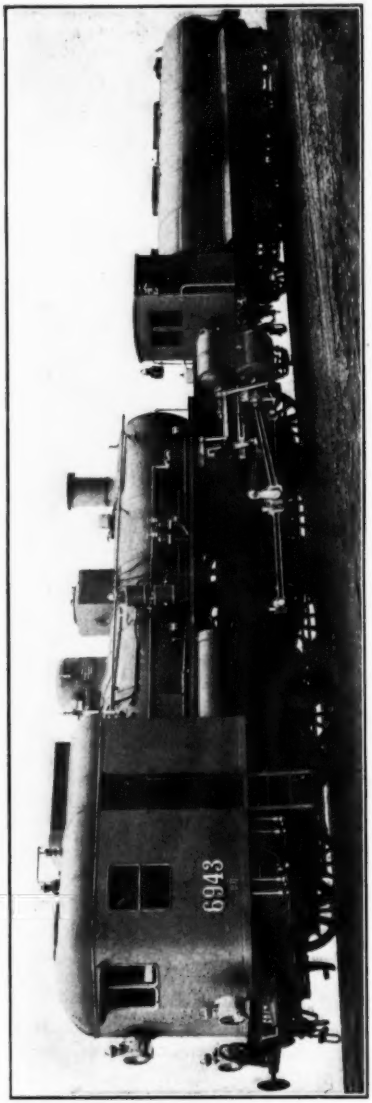


FIG. 38. ADRIATIC-TYPE LOCOMOTIVE OF THE MOST RECENT MODEL.

and total stroke of about 2 feet.

A forging which tends to become more and more intricate with the introduction of specially-shaped and wide fireboxes—derived from the Wooton and Belpaire wide-grate types—is the mud ring, foundation ring, or *cadre du bas du foyer* or *quadre fornello*. The Paris-Orléans' mud-ring (Figure 25) is, except for its shape, a simple piece, only having the two projections, as visible on the back end. This peculiarly shaped mud ring is forged from iron or extra-mild weld steel, the first having a tensile strength of 34 kilogrammes per square millimetre with 20 per cent elongation. For a grate of 4.27 square metres it weighs 460 kilogrammes. The Italian water-space frames are more difficult—see Figure 40. Here there are broad splay feet on the back end for bearing on the brackets riveted outside of the engine frames, and also large central blocks on back and front ends for maintaining the firebox central with the frames. They are forged from homogeneous iron having a tenacity of 37-44 kilogrammes and 20 per cent elongation. The inside and outside fire-

FIG. 39. STEAM HYDRAULIC FLANGING PRESS AT THE MILAN WORKS.

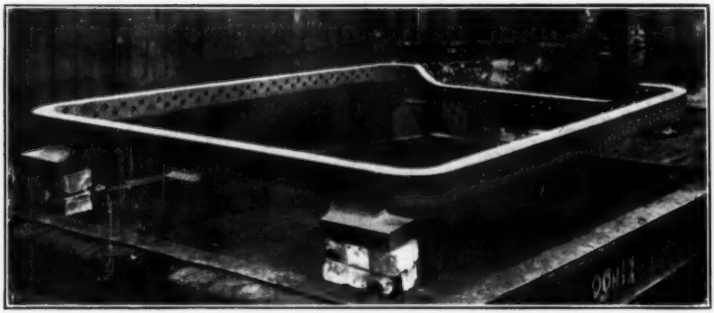


FIG. 40. MUD RING FOR PRAIRIE 0 OOO 0 LOCOMOTIVE.

boxes are further secured together by their fire holes, flanged and riveted together as in the Webb system, and by the copper stays in the sides, the latter being in part of ordinary arsenicated bronze and part of manganese bronze, 94 per cent copper, 5 per cent manganese. The ordinary stays have a tenacity of 23 kilogrammes, 35 per cent elongation, and the latter 30 kilogrammes and 30 per cent elongation. The firebox itself has copper plates of 22 kilogrammes tenacity and 35 per cent elongation. The stays are cut to the lengths required and screwed on the twin-head or duplex "Acme" screwing machine, Figure 41.

Crown stays and other stay bolts and ties are of mild steel 37-40

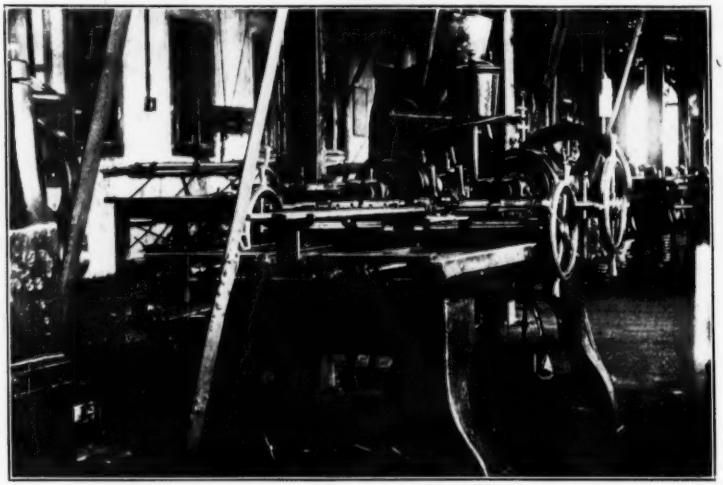


FIG. 41. SCREWING COPPER STAYS ON ACME DUPLEX SCREWING MACHINE.

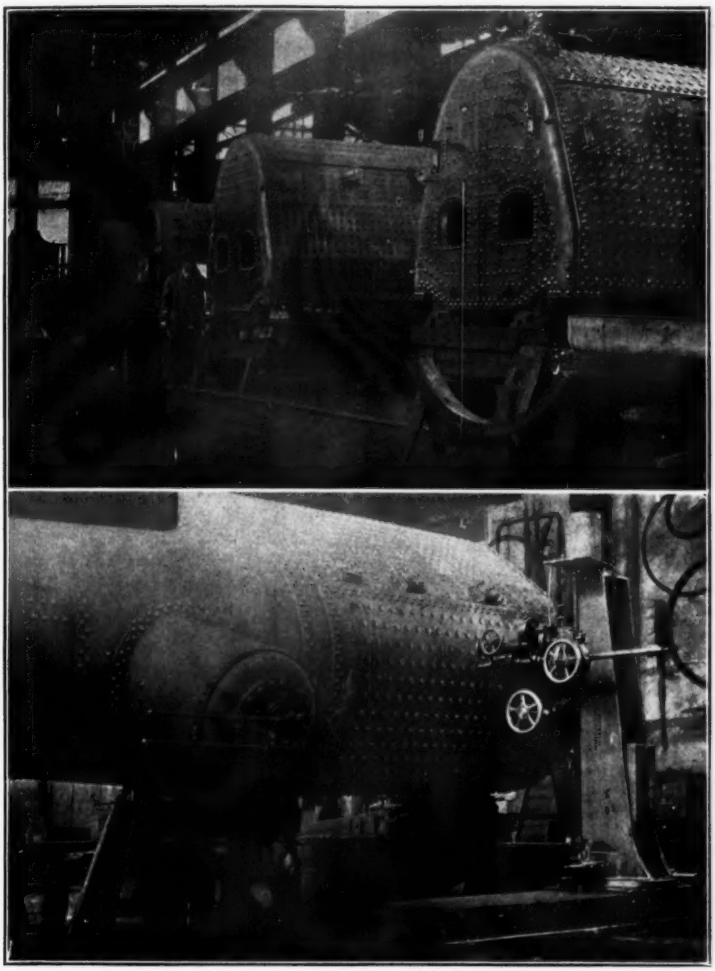


FIG. 42. WIDE FIREBOX BOILERS FOR ITALIAN FREIGHT ENGINES.
FIG. 43. SAWING OFF CROWN-STAY BOLT HEADS ON COLLET & ENGLEHARDT DRILLING AND TAPPING MACHINE.

kilogrammes tenacity and 27 per cent elongation. In the round-topped wide type fireboxes for freight locomotives shown in Figure 42 the crown stays have to be sawn off, after being screwed in place, to the angle of the crown sheet. A very handy semi-portable electric drilling machine by Collet & Engelhardt, shown in Figure 43 at work

sawing off bolt ends, is employed also for drilling, reaming, tapping and screwing home the stays of fireboxes. It serves a purpose and serves it well, but of all machines the boiler drill is of the most variable, no two makers having the same special requirements. At the La Chapelle, Paris, works of the "Nord" railway the boilers, on rails, are advanced under a rolling rectangular framework, from all sides and the ends of which, electric drills attack four sides of the firebox at the one time. Less elaborate than this, or the Maffei drill—Figure 6—is the compact semi-portable arrangement, used in many shops, made by the Saxon Engine and Tool Works of Chemnitz, Figure 44. This is of the horizontal type, with three drilling spindles variable in height, in angle and in longitudinal position, while the boiler can be conveniently turned around and about on its back by means of the rack and rollers on the three base plates. The boiler tubes now em-

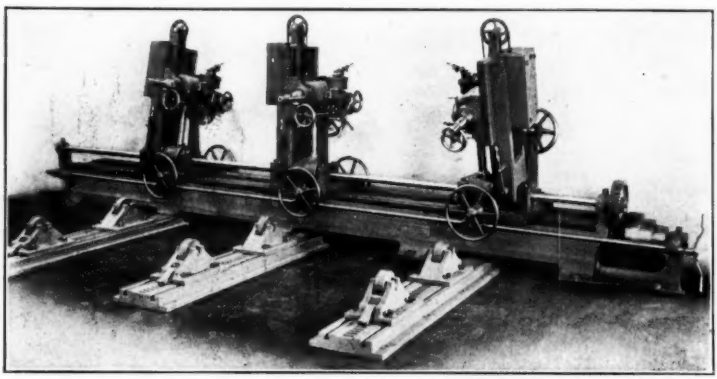


FIG. 44. TRIPLE HORIZONTAL LOCOMOTIVE-BOILER BORING MACHINE.

ployed for Italian locomotives are smooth, for, effective as were the Serve ribbed tubes, they have been found too rigid, and therefore liable to cause leakage of the flue sheets. The rupture of the firebox flue sheet—generally near the outside corners—is due to the considerable difference of dilation of tubes and of boiler barrel, and rigid tubes increase this trouble. Flues, until lately of brass, are for new Italian engines, once more of iron and with copper ends. The bottom of the boiler barrel is lined with 2-millimetre sheet copper to prevent corrosion. Some railways formerly employed cement, but it scaled at the seams—probably from some action of the red lead employed there. The grate bars are now steel castings. The whole generator of four-cylinder compounds weighs 20,880 kilogrammes.

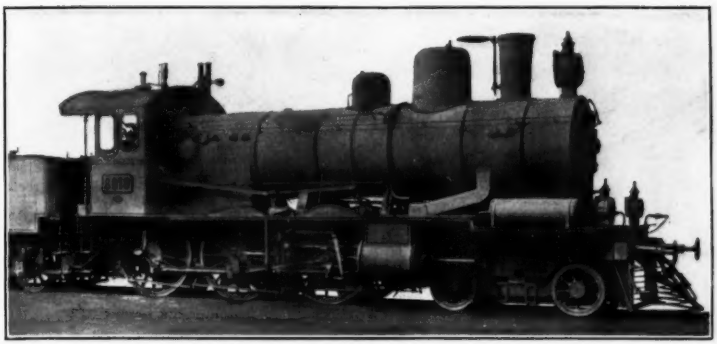


FIG. 45. oo OOO DE GLEHN LOCOMOTIVE FOR ROUMANIA.

The remarkable-looking *oo OOO* locomotive shown in Figure 45 was built also by the firm of Breda for the Roumanian State Railways. In this the de Glehn arrangement was followed for the cylinders of which the inside high pressure group is shown in Figure 46. The crank axle is of the Z type, but of round section for the sake of lightness and its design called for elaborate geometric [graphic] calculations. The axle load is very low and difficulty was experienced in making a large engine of this de Glehn type sufficiently light.

Denmark has also imported locomotives from Breda's. A bar frame of Prussian origin is constructed at Hannover for the *oo OO o* type balanced compound engines of the Danish Railways. This bar frame weighs, complete, 6140 kilograms. It has four cylinders, served by two piston valves which are so placed that a variable ratio of cut-off is not possible between the two valves as in the Italian locomotives, where each valve has its own reversing gear to adapt the engines to extreme variations in the conditions of service. The Saxon Engine Works

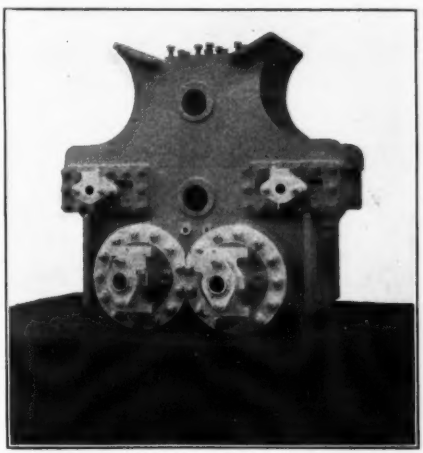


FIG. 46. INSIDE CYLINDER FOR ROUMANIAN oo OOO TYPE COMPOUND.

has also made bar frames, as shown in the view, Figure 47, but these were for exportation to Canada and were steel castings.

Belgium which had for a number of years relinquished initiative in the matter of locomotive design and had imported Scotch plans of Scotch engines, began building modern engine types in 1904 and the finest specimen, known as "Type 19," is of the Central European balanced compound arrangement with cylinders all exactly in line and driving on one axle only—the boiler being the plain simple Scotch type without superheater. Constructively, the engine is of the same disposition as Nos. 3302 and 3303, balanced non-compound engines, Figure 48, one of which has a superheater in the boiler tubes. In these latter, the rocker drive for the outside piston valves is similar in principle, if not in construction, to the gear Mr. Webb applied to his first four-cylinder balanced compounds. The third new balanced type is the engine illustrated in Figure 49 built by Cockerill's. Here the cylinders are in line, but their rods drive upon different pairs of driving wheels, as in the Henry system.

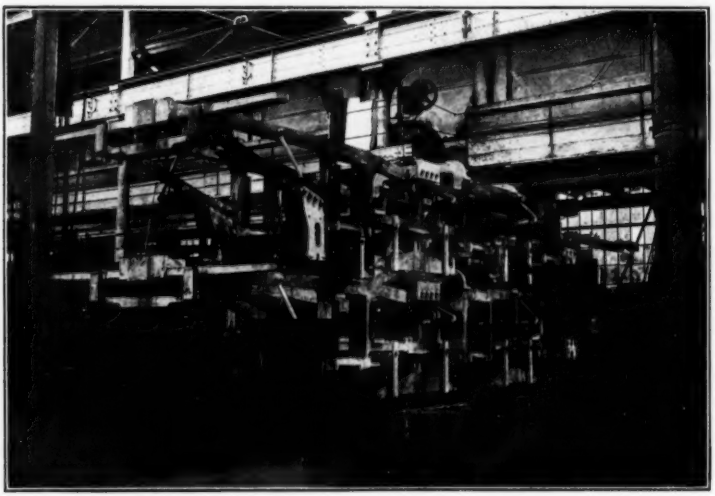


FIG. 47. BAR FRAME COMPLETE, AS MADE OF STEEL CASTINGS IN SAXONY.

In France the most recent type of locomotive of the Henry system was designed under Mr. Baudry, late of the Paris-Lyon Ry., in 1904, Figure 50. It has four valve mechanisms but the low-pressure variation is practically non-existent, as the cut-off for them remains at 63 per cent whatever admission is given by the high-pressure valves, thus differing from all other French distributions.

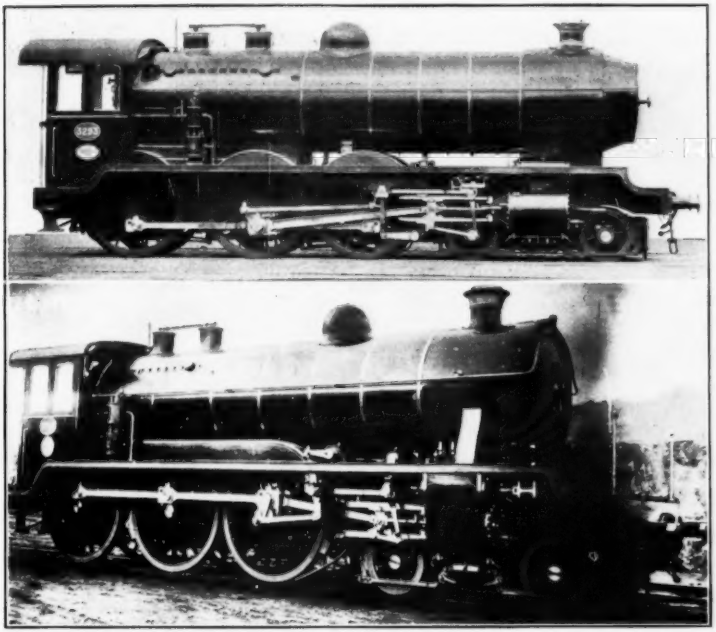


FIG. 49. RECENT BELGIAN BALANCED COMPOUND, REPRESENTING SCOTCH ENGINES ADAPTED.

FIG. 48. BELGIAN STATE FOUR-CYLINDER NON-COMPOUND, NO. 3302 SERIES.

The four-cylinder balanced "Adriatic" compound shown in Figure 38 is the last of its series. The enginemen, although infinitely better off with the reversed arrangement of the boiler, disliked the idea, in

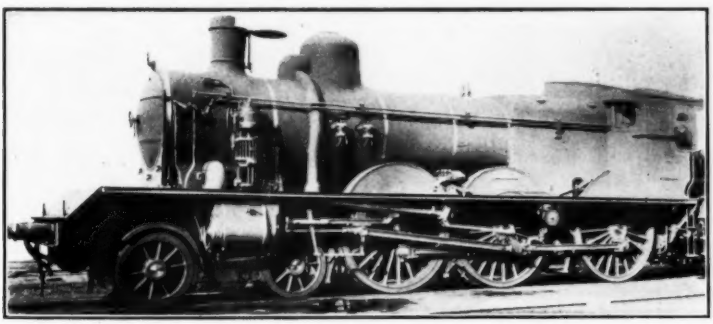


FIG. 50. MOST RECENT EXAMPLE OF HENRY-BAUDRY COMPOUND LOCOMOTIVE, PARIS-LYON RAILWAY.

prospect of head-on collisions, preferring to be between engine and tender in case of accident—as at Shrewsbury. For passengers' safety and for comfort of the enginemen the front cab was, by experience, shown to be unquestionably and vastly superior. The engine system survives in the new "Prairie" locomotives. Of these "Adriatic" engines, the chief engineer of the "material" testing department at Rome has reported as follows:—"By the experience of the last four years we know that, regularly hauling express trains weighing 200 to 350 tons behind the tender, these 'Adriatic' engines only consume, on

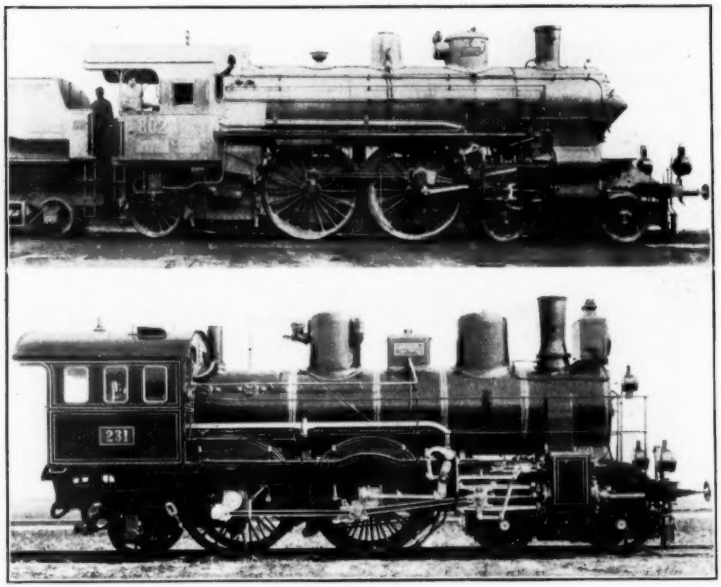


FIG. 51. FIRST BALANCED COMPOUND, HUNGARIAN STATE RAILWAYS. EXCEPTIONALLY FAST ON LEVEL LINES.
FIG. 52. NEW TYPE COMPOUND, RUSSIAN RAILWAYS. PLATE FRAMES.

average, 13 kilograms of coal per kilometre, that is, hardly 5 per cent more than the single-expansion engines which take, on average, 100 tons less and frequently require piloting." These engines are unusually economical. They regularly save 35 per cent of the coal used by single-expansion engines operating the same service of trains—the yearly returns showing the fuel consumption per 100 car kilometres run to be 6.73 kilogrammes for single expansion and 4.37 kilogrammes for double. It would be daring to assert that no single-

expansion was ever so economical on fuel, but this much is indisputable—that they are more economical and more powerful, weight for weight and wheel for wheel, than has recently been shown as the "ideal maximum, but not realisable in regular service," obtained exceptionally in specially prepared trials of locomotives fitted with patented superheaters whose effects were claimed to be so brilliant that similar results had never been obtained by saturated steam in engines of the same weight and number of axles—results which have, however, been far exceeded by the "Adriatic" type locomotives in regular service according to the routine records of their work.

Hungary is the most recent place of adoption of the Central European compound locomotive, see Figure 51. This is, however, the only example of such in which an intercepting valve is employed, much though the elimination of this organ has been studied elsewhere. In service, remarkably high speeds have been attained with this engine. The valve rockers are similar to those of the Belgian locomotives type "19" and "19 bis."

An example of Russian compound locomotive figures in Figure 52. This country has been the earliest home of the Mallet original two-cylinder compound and the Mallet articulated four-cylinder compound locomotives, and it is certainly remarkable that superheating the steam in that country does not appear to produce any result worthy of mention. Other compound systems, as the de Borodine-Wolff tandem system, have, in their time, there been productive of results even difficult at times to be equalled by the Italian compounds.

In the future, water-tube boilers, with superheaters, and compound engines, with improved valves, may be expected greatly to increase the economy and working capacity of locomotives until the arrival of a substitute for the turbine—which experiments show to be wholly unsuitable for such machines.

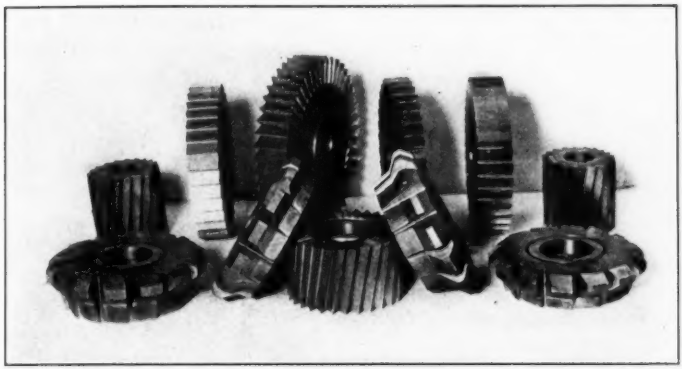
HARDENING HIGH-SPEED STEEL TOOLS BY THE BARIUM-CHLORIDE PROCESS.

By O. M. Becker.

Thorough study of the alloy steels, and especially of the rapid-cutting types, has solved many of the difficulties that sometimes led to disappointment in their use in earlier days. One point very clearly fixed is that comparatively small temperature-differences in heat treatment are the cause of very great differences in the properties developed. The methods defined by Mr. Becker are among the improvements enabling exact results to be secured in regular practice. In a later issue we shall present a very thorough review of the whole range of the special steels and their qualities, by M. Léon Guillet, one of the foremost experimenters in the field.—THE EDITORS.

BEFORE the day of high-speed steel even, it was felt that there should be found some method of hardening which would obviate the nuisance of oxidation and scaling of the surface of fine tools. The advent of high-speed steel, with its much higher hardening temperatures, emphasized the evil of scaling. This has made the discovery of some simple process of hardening which would avoid the difficulty, or reduce it to a negligible minimum, a matter of much concern. It is well-known that as ordinarily treated, fine tools often lose size, and in general have to be made over-size in the first place to allow for the refinishing necessary after hardening and tempering. The various methods of packing tools in muffles and similar devices, while troublesome, help a good deal to overcome the trouble; but even these methods do not entirely remedy the difficulty. The lead bath, reasonably satisfactory in the case of carbon-steel tools, cannot be relied upon in the case of high-speed steel tools.

Lead melts at a relatively low temperature, but can be raised to that required in hardening the new steels without great difficulty. At this high temperature however the lead oxidizes rapidly, leaving a scum of lead oxide floating on the surface to obscure the appearance of the bath. But while it can be used, and is used regularly by some tool makers, it is more or less uncertain, and besides does not prevent some oxidation while the tool is passing from heating bath to quenching bath, if one be used. Not infrequently this alone is sufficient to ruin a delicate tool, though ordinarily it is of no particular consequence in carbon-steel tools. With high-speed steel tools the very high temperature (a dazzling white) at which the tool is car-



TYPES OF HIGH-SPEED TOOLS FOR WHICH THE BARIUM PROCESS IS ESPECIALLY DESIRABLE.

It leaves perfect surfaces and cutting edges, does not impair the accuracy of size, and makes it possible to have very hard cutting edges combined with tough stocks or bodies.

ried from the heating furnace or bath to be quenched, frequently causes trouble, if indeed it does not necessitate refinishing the tool by reason of impaired size or damaged cutting edges. When the quenching is done in an air blast the trouble obviously is accentuated. The oil quenching bath of course prevents this part of the trouble, and this is now coming to be more and more generally used.

Another troublesome point in the hardening of fine tools, especially of small ones or those having keen cutting edges, is that of securing absolute, or even approximate, uniformity of temperature in heating. This exceedingly important result is, in the case of such small tools, rather difficult of attainment by reason of the frequent and sometimes considerable fluctuations in the interior of a gas furnace, which latter is otherwise undoubtedly better adapted to the heating of high-speed steel tools than any other type. With large tools these fluctuations, arising from variations in pressure, areas of openings, and the like causes, make little difference on account of the considerable length of time required to affect a large mass. In the case of small ones however, where the time of heating is comparatively short, any such fluctuation may be sufficient to affect the quality of the tools. This difficulty also has been overcome in the past by the use of the lead bath and muffles, which however have the disadvantages already mentioned.

The distortion sometimes occurring in long and slender or specially shaped tools, when heated in the ordinary gas or coke fires,

THE BARIUM PROCESS LEAVES THE SURFACE OF A TOOL ABSOLUTELY UNIMPAIRED, IF IT BE QUENCHED IN OIL.

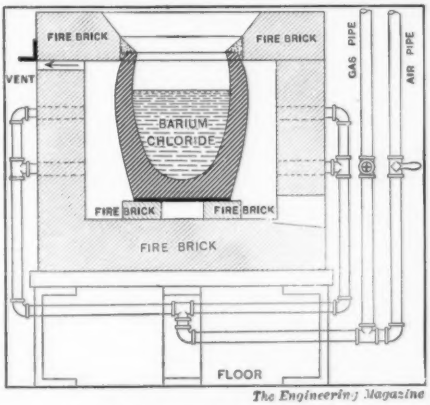
The only difference in the appearance of hardened and unhardened tools is a very slight darkening of the color, so slight as to be unnoticeable except when compared with an untreated surface.

causes trouble. This is avoidable in part in all cases, and wholly in the case of straight tools, by heating them suspended in a cylindrical gas furnace. Ever since the advent of the new steels, these difficulties have suggested the need for some method of heating tools of this sort which would do away entirely with oxidizing, warping, refinishing, and the like troubles. In Europe particularly, experiments were carried on from time to time with the purpose of developing such a method, and with some success.

It was in Germany, I believe, that a bath of melted barium chloride was first used to replace the lead bath; and I am told that in the shops of the Ludwig Loewe Co., at Berlin, it was used to a considerable extent in their work of hardening high-speed tools. It was not however either generally known or practicable for general use until the importance of the process was recognized by the eastern representatives (Wheelock, Lovejoy & Co., Boston) of the Firth-Sterling Steel Company, and by them and by the Chicago representative of the same company (E. S. Jackman) developed by long and patient experimentation to its present state of utility. These people not only use the process extensively in their own hardening plants for the benefit of their customers, but have made known the method to all inquirers.

Essentially the barium-chloride process consists in melting the commercial substance of that name in a suitable vessel and heating it to the required temperature. The tool to be hardened is then plunged into the bath until it has reached the temperature of the bath (except as hereafter indicated) and is then withdrawn and quenched in the customary manner, preferably in an oil quenching bath. Barium chloride is, as its name indicates, a compound of barium, which latter is one of the so-called alkaline earths, belonging to the same group as calcium (lime) and strontium. The chloride, like the other barium salts, is poisonous.

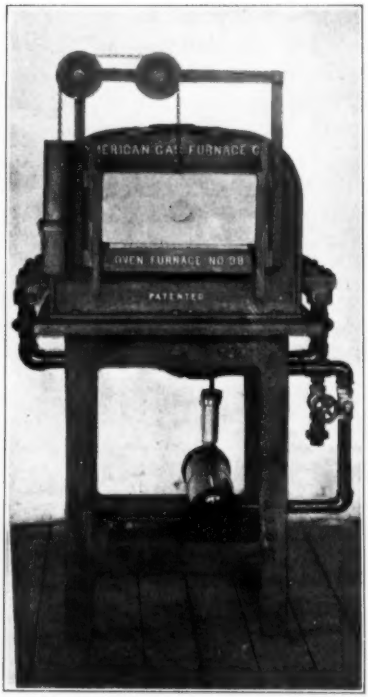
Barium chloride melts at a temperature considerably below that required in hardening high-speed steel; but it can be readily raised and maintained at the required temperature (approximately 2,150 degrees Fahrenheit or 1,180 degrees Centigrade) in a suitably designed furnace. A graphite crucible is necessary, and even this must have the bottom well supported to prevent its dropping out. The crucible is placed at the center of a cylindrical furnace somewhat resembling those sometimes used in ordinary hardening, and sealed to the top with fire clay in such a way as to prevent the escape of gases from the furnace body except through the vent. The gases must not come into contact with the melted barium chloride.



The Engineering Magazine

DIAGRAM OF BARIUM CHLORIDE FURNACE.

Either oil or gas may be used, in a furnace adapted to the particular fuel, though in general gas is recommended because of its greater convenience and the greater ease with which exceedingly high temperatures are reached and maintained. A gas furnace in which the flame has a rotary motion around the crucible has been adapted to this use by at least one builder of furnaces. The nozzles from which the mixture of gas and air issues are placed tangentially to the inner surface of the furnace, throwing the flame not directly against the crucible in one or several spots, but enveloping it in a whirl of flame which heats it uniformly on all sides. The firebrick blocks upon



LARGE OVEN FURNACE AS USED IN PREHEATING LARGE TOOLS PREPARATORY TO PLUNGING INTO THE BARIUM BATH.

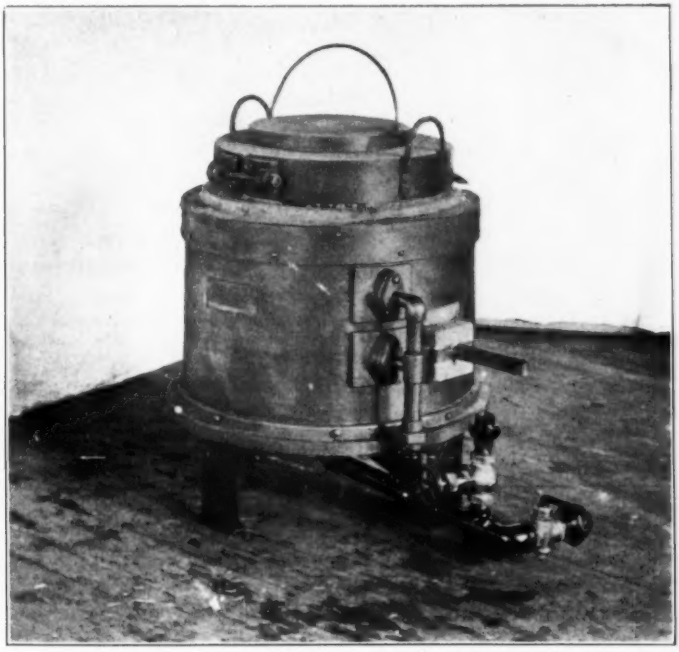
The same furnace is an excellent one for the ordinary hardening work.

which the crucible rests are so disposed as to allow the flames to circulate below, as well as around the crucible, the contents of which are therefore kept at a uniform temperature throughout—an important condition to success with this process. The furnace of course is supplied with both air and gas under pressure, the air being supplied preferably by a small blower. Furnaces can be had equipped with individual blowers, if desired. Ordinarily, in a plant where a number of furnaces of the several kinds useful in the treatment of tools are installed, a single blower for the group is most economical. Not only the barium furnace, but all others in a hardening plant, and the quenching bath also, should be provided with suitably designed exhaust hoods, properly connected up, for the removal of gases and for frequently changing the heated air of the room. The chlorine fumes rising from the barium-chloride bath in spite of precautions to prevent, are very irritating when breathed.

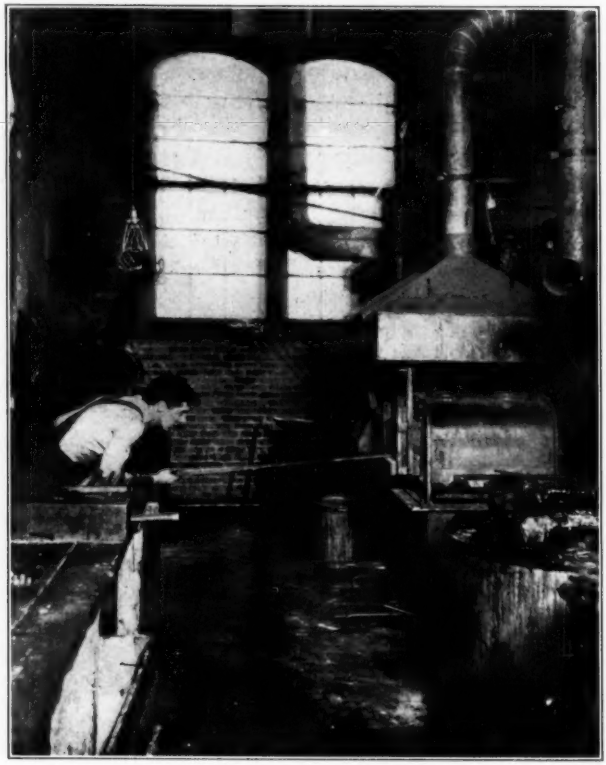
A well equipped hardening plant will of course have a considerable variety of furnaces and other apparatus, especially adapted to the various kinds of work. In addition to the barium chloride furnace there will be the large oven furnace for heating large tools and for reheating certain classes of tools preparatory to the barium bath treatment; and perhaps a small oven furnace. A lead bath is almost indispensable where there is a wide range of work. There should be also an oil tempering furnace, for "drawing" the temper of such tools as require this treatment.

The various furnaces may of course be heated by any desired fuel adapted to them, and in some cases will vary from the forms men-

tioned. A coke furnace, for example, would replace the oven furnaces mentioned above. The furnaces preferred are all gas-heated, these being most convenient to operate and most certain in control. The cost of operation, moreover, is little or nothing higher than that of the other forms unless the price of gas is exorbitant. In that case a small plant for manufacturing gas would be desirable. Provisions for quenching, of course, are essential. And finally, there should be a fairly good pyrometer, for observation of temperatures. The novice especially needs the guidance of such an instrument. Pyrometers suitable for this purpose are now obtainable in a variety of forms, both reading and recording, at very moderate cost; and these give very satisfactory service, some of them continuously and accurately with little or no attention. Such an adjunct to a hardening plant is of course desirable, and indeed essential, under ordinary circumstances; but it is especially important in connection with the barium bath, while the operator is becoming familiar with the process, if not later.



A CYLINDRICAL FURNACE (HOOD NOT IN PLACE) WITH GRAPHITE CRUCIBLE. Used in hardening high-speed steel tools by the barium-chloride process. Made by the American Gas Furnace Co., New York.



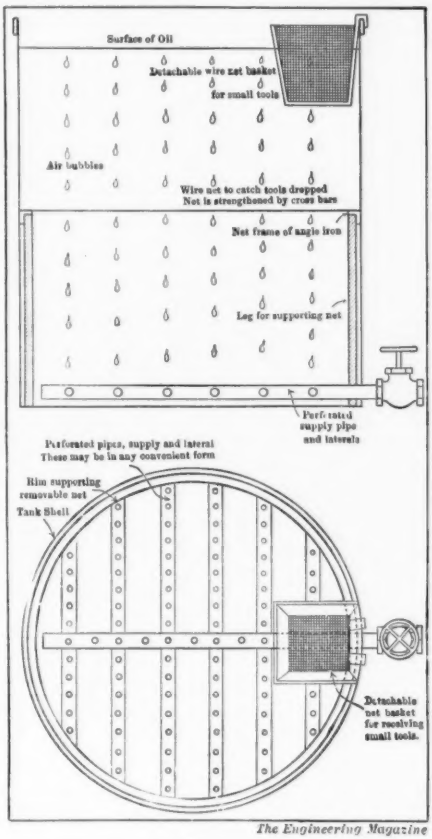
A TYPICAL ARRANGEMENT OF A TOOL-HARDENING PLANT.

The furnaces and other apparatus are preferably placed in a straight row, and each unit provided with an exhaust hood for drawing off the fumes, as well as helping to renew the air of the room.

A word as to the arrangement of the units of a hardening plant may be of interest. The point of course is to so arrange them as to be most convenient. A good order would be, beginning at the left: Large oven, small oven, lead bath, barium bath, quenching bath; and oil tempering furnace. The line should be straight. The more convenient semicircular arrangement is impossible because of the intense heat concentrated upon the operator, in this case.

The quenching, as already mentioned, can be by any of the methods customary with high-speed steel. Water, of course, must not be used. With the barium-chloride process air quenching can be used to better advantage perhaps than ordinarily, for no oxidation of the

tool can take place in it after the latter is taken from the heating bath. Air however is more expensive to use than is the oil bath, and has no advantage over it. It is recommended that wherever practicable, all quenching, whether of tools heated in the barium-chloride bath or otherwise, be done in an oil bath. An excellent form for this purpose was illustrated at page 249 of THE ENGINEERING MAGAZINE for November, 1905. A still better form for all-round use is illustrated herewith.


Surface of Oil
Detachable wire net basket for small tools
Air bubbles
Wire net to catch tools dropped Net is strengthened by cross bars
Net frame of angle iron
Leg for supporting net
Perforated supply pipe and laterals
Perforated pipes, supply and lateral These may be in any convenient form
Rim supporting removable net
Tank Shell
Detachable net basket for receiving small tools.
The Engineering Magazine

A GOOD DESIGN FOR TANK FOR OIL QUENCHING.

At the bottom of a cylindrical galvanized iron tank is laid a series of pipes branching from a central supply pipe, all perforated in the upper side. Air from the blower, or from the compressor if the pressure has been sufficiently reduced, bubbles up from the bottom, keeping the oil in the tank in circulation. It is therefore kept well mixed and of uniform temperature, and the temperature is kept sufficiently low by the loss of heat to the air bubbles constantly escaping.

About half-way to the bottom, or elsewhere as required, a removable wire netting is placed, properly supported, to catch any large tools that might accidentally be permitted to slip from the tongs. If the netting be near enough to the top the tools can be dropped into the bath and removed at pleasure. Besides the netting mentioned, there is at one side of the tank a removable net basket, of mesh fine enough

to prevent any tool that might be placed in it from falling to the bottom of the tank. Into this basket all small tools are dropped for quenching, to be removed as desired.

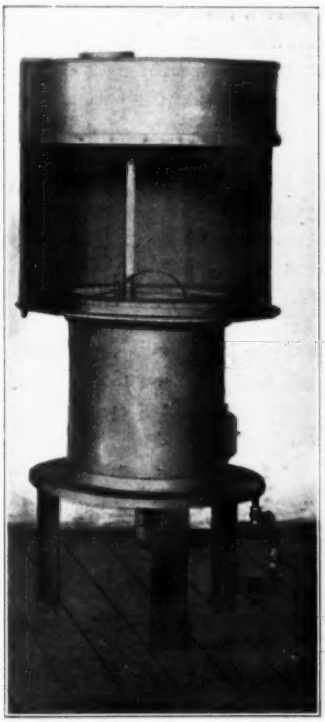
When tools are to be hardened, the crucible is filled with commercial barium chloride (the cost, in quantity, is about three cents per pound), which is melted. Into it is then thrown a handfull of sodium carbonate, commonly known as soda ash. This should be about 2 per cent of the contents of the crucible. It floats upon the barium chloride and partially prevents the latter giving off the offensive chlorine fumes which not only are irritating when breathed, but discolor tools with which they come in contact. The ash seems to have some additional effect, as yet not very well understood. It must be renewed from time to time, as it becomes exhausted; but care must be taken not to have an excess of it. In that case the boiling point of the barium chloride is altered, and the temperature cannot be raised high enough to give the tools a proper hardening heat.

The bath is rapidly brought to the required temperature, which for high-speed steel ranges from about 1,000 degrees to 1,180 degrees Centigrade, or 2,000 to 2,125 degrees Fahrenheit, or thereabouts. This is slightly lower than the temperature usually preferred in the ordinary hardening furnace, but is sufficient for the kind of work to be done. In the open furnace, when heating unfinished tools, the temperature is preferably raised to the point where the flux begins to run, 100 degrees or more above that just mentioned. But where keen edges are to be preserved, as in tools best hardened by the barium-chloride method, it is not safe to bring the heat quite so high. Until the operator has become thoroughly familiar with the appearance of the bath at the proper temperature, he should give the pyrometer frequent readings.

Large tools, say those above ⅜ inch in diameter or thickness, are generally pre-heated in a gas furnace, the heat however not exceeding a low red. At this temperature there is little or no surface oxidation, and pre-heating may safely be done with most large tools intended for the barium bath. The object of pre-heating is to prevent a sudden lowering of the temperature of the barium bath upon the introduction of a large mass of cold steel, and the consequently longer time required for the heating, as well as the need for carefully readjusting the temperature of the bath to the right point. Pre-heating saves considerable time when many tools are to be hardened. It is objectionable however in the case of smaller tools (which do not need it) and tools with keen edges to preserve, because of the exceed-

ing care required to prevent oxidation either in the furnace or on the way to the barium bath. When it is necessary to pre-heat such tools, it is best done in a lead bath.

Small tools plunged cold into the bath quickly heat through and do not noticeably affect the bath itself. According to the diameter or thickness of the tool, from a fourth of a minute to a minute is required when the tool is to be heated through, as it should generally be. Larger tools of course take longer. The dazzling white is easily recognized, and the operator has but to examine the tool from time to time, in order to be sure it is hot enough for quenching. Thus immersed the tool heats uniformly from all surfaces toward the center.



CYLINDRICAL OIL TEMPERING FURNACE WITH HOOD.

Used for "drawing" the temper of such tools as require this treatment. The thermometer is essential to this type of furnace. American Gas Furnace Co.

When withdrawn from the bath the tool is covered with a thin film of barium chloride, which adheres to the surface until quenching, and ordinarily prevents air coming in contact with the tool itself. There is consequently no oxidation, unless the tool be quenched in an air blast. The film disintegrates in the air blast and permits some oxidation to take place. The surface of the tool, after the scales of barium chloride have been brushed away, comes from the oil quenching bath with almost exactly the same appearance it had before heating, and the finest finished surface is absolutely unaffected. Even an expert cannot tell the difference, except perhaps by a darkening of the color so slight as to be quite unnoticeable except when compared directly with an untreated surface. From its appearance alone no one would suspect a high-speed steel tool to have been heated, when hardened by the barium-chloride process. It is seen therefore, that there is no need whatever for refinishing or grinding tools so treated. The keenest cutting or finishing tool is not impaired in the slightest degree.

This is of especial advantage in such tools as taps, threading dies, screw-machine formed tools, and the like. Formerly high-speed steel was little used for tools of this sort. It was difficult to harden them without their losing size and more or less roughening the surfaces and cutting edges. The barium process entirely obviates this difficulty, and also another which formerly gave much trouble. Tools with projecting or overchanging cutting edges, when hardened in the customary way, were too brittle and the teeth or cutters frequently broke away. When the body of the tool was small, that also was liable to breakage. If the temper was reduced enough to overcome this trouble, the tool usually was too soft to give the best service. The improvements in high-speed steel itself have done much to eliminate this trouble. However that may be, nothing of the sort can occur if such tools are given the indicated treatment with the barium process.

By plunging a tool, as a tap for example, into the barium bath just long enough to let the cutting edges become heated to the hardening temperature, and then withdrawing the tool before the stock has had time to get very hot, it may be quenched with the result that the cutting edges alone are hardened, the stock remaining in the annealed state and retaining all its toughness. This same quality, that of a very hard cutting edge combined with a tough stock or body, is desirable also in many other kinds of tools, especially in twist drills, milling cutters, and the like.

It should be remembered, in thus hardening tools of this class, that flaws often result from strains set up in hardening, generally by reason of the outside portions of a tool cooling and hardening more rapidly than the interior, and the consequent tendency of the outside and inside portions to adjust themselves. The interior of tools thus heated on the outside only does not expand much if at all; and when the highly heated thin outer skin is quenched, the sudden shrinkage sometimes causes flaws. A little care on this point will prevent the difficulty.

The tempering or "drawing the temper" of those tools needing it, as most keen-edged tools do, is accomplished in the customary way, preferably in the oil tempering furnace, as has been explained in a previous article in this magazine.*

* Page 251, THE ENGINEERING MAGAZINE, November, 1905.

ALCOHOL AS A FUEL FOR INTERNAL-COMBUSTION ENGINES.

By Thos. L. White.

Mr. White examines, in the following pages, the problem of obtaining cheap and ample supplies of fuel alcohol from a variety of raw materials. In a subsequent article he will discuss the suitability of alcohol as a substitute for gasoline.—THE EDITORS.

THE object of the present article is to offer an analysis of the various elements which enter into what may be termed the industrial alcohol situation in America at the present time. That there is great need of some such process of "stocktaking" is evident from the experience of the past two years, which has shown conclusively that European standards and precedents have little application in America because the accompanying conditions cannot be reproduced, and that consequently the problem of the development of the alcohol industry in America is in essentials a problem *de novo*. It is to frame a tentative answer to such questions as:—What will alcohol be made from? What will the price be? Can it be used for automobiles? Will it ever take the place of gasoline?—that the present survey is intended; and that such an attempt is even now feasible is due to the large body of technical information which has recently become available for reference, and which we owe to various investigating committees, notably, the Technologic Branch of the U. S. Geological Survey, the Office of Experimental Stations of the U. S. Department of Agriculture, the Fuels Committee of the Motor Union of Great Britain, and to such private investigators in the same field as Prof. Lagerheim of Stockholm University, Mr. Victor Frestadius, Sir William Ramsay, Eckardsström and Raynaud.

Few recent measures in passing Congress attracted wider attention or gave rise to more lively anticipation in all quarters of benefits to come than the Payne Act making industrial alcohol duty-free, and the public attitude towards the net result to date, viz., denatured alcohol at 40 cents per gallon in five-gallon lots, and that procurable only in important centers, is naturally one of some disillusion. In justice, however, to the future of a very young industry, and in a lesser degree to those engaged in the manufacture of the new product, it must be conceded that this high price is in the main due to causes which are being, or which can be, modified.

In the first place, although industrial alcohol has been duty-free, so far as the statute book is concerned, for fifteen months, it is only during the last six months that the industry has been freed from certain vexatious, expensive, and, as has proved, quite unnecessary regulations by which it was hampered at the start, and which virtually constituted an indirect tax. These were framed by the excise authorities with a too zealous eye to the safeguarding of the revenue from spirits, and entailed a needless outlay of about 6 cents per gallon on the distiller, who, of course, added the charge to the retail price. Whether the consumer has as yet enjoyed the full relief coming to him, only the producers of alcohol are in a position to say.

In the second place, the alcohol furnished to the American market to-day is almost exclusively a corn product, and corn during the past year has fluctuated around the 60-cents-per-bushel mark, a price much in excess of normal. While it would be absurd to credit the whole difference between the actual price of alcohol and the price at which we should like to see it to the present inflated condition of the corn market, there is no doubt that when the present high price has had time to react by increasing the acreage under cultivation, alcohol will be procurable at a more reasonable figure. Whether corn will continue to be the principal alcohol base, and whether corn-made alcohol will ever be cheap enough to be substituted for gasoline as a fuel, are questions of normal limitations rather than of market conditions: but as we shall point out presently, there are other raw materials for the manufacture of alcohol which seem more promising.

The fact of the matter is that in its inception, and up to the present, the production of industrial alcohol has been in the hands of the whiskey distillers. This was inevitable, for they were the only people equipped to supply the market at the time of the passing of the Payne Act, and they naturally continued on the lines to which they were accustomed, regarding the new product, not as the basis of a new industry, but as so much additional output of an old one. If things had not fallen out this way, the result would have been, not cheaper alcohol for heat, light, power, and the manufactures, but no alcohol at all. A price reflects, not prospective industrial conditions, but actual industrial facts, and while there has been a good deal said and written about farmers making alcohol in co-operative stills from farm refuse, and visions of alcohol at 3 cents per gallon from corncobs have been vouchsafed to enthusiastic souls, the benefit to the consumer of alcohol from these sources has been confined to the realm of theory.

There are no statistics bearing on the point, but it is not probable that the passing of the Payne Act was heralded by any extensive or

sudden demand for the new product. So far as alcohol for the purposes of heat and light is concerned, such a demand would premise a distributing system, the education of the people to the use of alcohol as a source of heat and light in the house, and the supplying them with suitable lamps, stoves, and similar apparatus. With regard to the use of duty-free alcohol in the arts and manufactures, those industries which had been compelled to use alcohol in the past merely continued its use under the new law, the output of their product, and consequently their consumption of alcohol, remaining virtually the same. In other industries, where the use of grain alcohol and wood alcohol was alternative, but the former the more advantageous in practice, the change over to the new product did of course constitute a new demand; but in the vastly more important field of motive power, the high price of alcohol, the difficulty of obtaining it, the general lack of knowledge regarding its use in motors, and the abundance of cheap gasoline, seemed in their cumulative effect the practical negation of the opinion of every expert who has examined the fuel question, and of every technical committee that has sat on it, that alcohol is the coming fuel. In fact it has become fairly evident that even if new and economical systems of making alcohol from farm refuse, sawdust, and what not, had been actually established at the time of the passing of the Payne Act, there would have been practically no market for the alcohol produced. This is directly opposed to popular opinion which places the onus on the distiller, but it is nevertheless true; and it means, not that the alcohol industry was still-born, but that it needed, and yet needs, time to find itself.

It is the sovereign claim of alcohol, and the principal ground of the belief that it will one day supersede all other liquid fuels, that it is the product of the four seasons. It is made by converting to sugar, and then fermenting, the carbohydrates in plants and vegetables, and its production has no limit set to it by the ultimate exhaustion of some natural reservoir of stored energy, such as a coal measure or an oil field. So long as the annual cycle of plant generation goes on, so long can alcohol be produced, for alcohol takes nothing from the plant but carbon, oxygen, and hydrogen, and these elements are supplied to each succeeding generation of plant life by the moisture and carbon dioxide of the atmosphere.

From an economic point of view, the most valuable of the elements that enter into plant life is nitrogen. It is taken up into the structure of the plant from the soil, and it can be assimilated by the growing tissue only when it is presented in the form of a soluble nitrogeneous compound. In a state of nature, the decaying vegetation

returns to the soil the nitrogen that it has taken from it, but when land is under cultivation, the soluble nitrogen is removed with the crops, and the ultimate exhaustion of the soil is only a matter of time. In new countries, where large and fertile tracts are available, this depletion of the nitrogenous content of the virgin soil is not of immediate importance, but in settled districts it represents a problem of the first magnitude. Now, as we have pointed out, nitrogen does not enter into the composition of alcohol, so that the manufacture of alcohol does not constitute a direct drain on the nitrogenous capital of plant life; nevertheless if the residue from the alcohol stills, which contains the combinable nitrogen of the base from which the alcohol is made, is not returned to the soil but is wasted or otherwise dissipated, the result is virtually the same. In order, then, that the claim made for alcohol—that in its production the fertility of the soil is conserved—may hold good in practice, it is clear that the relation between agriculture and the manufacture of alcohol must be of even a closer character than is implied in the mere statement that alcohol is an agricultural product. We should in fact expect the distilleries to be situated in the agricultural districts, and the base from which the alcohol is made to be selected with an eye not only to the fermentable yield, but also to the suitability of the residues from distillation for use as fertilizers. As a matter of fact, in France and Germany where the problem of producing alcohol has been worked out to suit the requirements of a soil that has long been cultivated, there is a large majority of agricultural distilleries, and the value of the residues represents 50 per cent of the value of the alcohol manufactured.

Mention has been made of the difficulty of adapting foreign standards to American conditions, which prevents the general application in the United States of experience in the alcohol industry gained on the other side. One of the reasons of this is that in its diversity of agricultural and industrial conditions the United States is not a country but a continent. Take the case of the German agricultural distilleries which we have just cited as illustrating the tendency of the alcohol industry to graft itself onto the nitrogen cycle of agriculture. It would not be difficult to find sections in the State of New York where the land has been worked long enough to render the question of residues as important as in Germany. Suppose that in some such section the farmers undertook the cultivation of the alcohol potato and erected co-operative distilleries, trusting to sell their alcohol in the cities. What is there to prevent their enterprise from being ruined by the competition in a common market of alcohol made, we will say, from sugar refuse in the southern States and shipped in tank steam-

ers? The German farmer is protected from this sort of attack because the agricultural conditions in Germany are sufficiently uniform to be treated and looked after as a unit. Nor is the difference in the economic conditions of the production of alcohol as between America and Europe any less marked. The widest field for industrial alcohol is without doubt as a source of heat, light and power, and it is precisely in this field that alcohol in America is subjected to a degree of competition to which in Europe it is a stranger. On the other side petroleum products are a heavily taxed import, while the manufacture of alcohol is State-aided. In America, kerosene and gasoline are to all intents and purposes natural resources of the country, and the standard of cheapness thus set for fuel alcohol is one that seems hard to meet without recourse to new methods of production. Those in vogue at present reduce on examination to a number of alternatives each no better and no worse than the rest, and all inadequate. There is no merit in resting in the belief that the Payne Act had some of the quality of an edict from above, and that alcohol was ordained from the first to replace gasoline. Providence in commercial matters is generally found on the side of low prices, and alcohol is a better fuel than gasoline only provided that it can be made cheap enough. In order to reconcile the immense possibilities of alcohol on the one hand and the unrealised promises of the Payne Act on the other the situation seems to call for something more radical than has hitherto sufficed —some departure which will enable alcohol to be used for whatever purposes its qualities best suit. That the oil wells are being exhausted and that the demand for the lighter petroleum distillates is increasing faster than the means of meeting it, is probably true; but the actual problem which at the present moment faces the producers of industrial alcohol in the United States is to find a base for fuel alcohol which is comparable in price with the crude oil from the wells. In brief, is it practicable to make alcohol on commercial lines from some material which may be had for the taking, and of which there is a great and easily accessible supply? In the light of the successful manufacture of alcohol from peat by Lagerheim and Frestadius, two Swedish chemists, an affirmative answer seems at least possible.

Although the normal cycle of plant life is to return to the soil the elements taken from it, there exist certain conditions under which this process of restitution may be suspended indefinitely, and the remains of countless generations of plant life preserved in a state of arrested decay. Deposits of vegetable matter formed in this way are known as peat bogs, and they can exist only where the subsoil is capable of retaining water, the climate humid, and the mean tempera-

ture sufficiently high to stimulate a rapid growth of the aquatic plants to which the peat owes its formation. The result of such a combination of conditions is that the decaying sedge in the early stages of its decomposition becomes pickled, the "pickle" being furnished by the decaying vegetation itself, in the form of certain peat acids of an antiseptic character which act as a preservative. The important point to the alcohol manufacturer is that the decay of the peat-forming plant life is arrested before its qualities as an alcohol base have become impaired, and the early recognition of this fact led a number of investigators to try to turn it to practical use. They were all however unable to surmount certain difficulties, the character of which they failed to understand rightly, and it seems to have been reserved for Lagerheim and Frestadius to be the first to work out a satisfactory process. Their discoveries have been corroborated by the investigations of Sir William Ramsay, Raynaud and others.

The species of peat which is best suited for the production of alcohol is that found in the extensive peat fields of North America, and technically known as sphagnum moss. It is procurable in a good state of preservation down to 30 feet in depth, and to give some idea of the alcohol content of such deposits, it may be stated that the Great Dismal Swamp of Virginia is alone capable of yielding 40,000 millions of gallons of 96 per cent alcohol, or sixteen-hundred times the total output of Germany in one year.

To avoid unnecessary handling of the peat the apparatus for the new process is designed for erection in the vicinity of the peat bog from which the raw material is taken. It consists primarily of a battery of closed boiling vessels or autoclaves, each of which is connected by a common pipe to a steam-generating plant. There are two manholes in each vessel, one at the top to admit the wet peat, the other at the bottom for removing the treated charge.

The first stage in the treatment of the peat consists in digesting it with sulphuric acid and water in the autoclaves, steam being meanwhile admitted through the steam pipe connection until most of the air in the peat has been slowly expelled. The temperature is then allowed to rise until a pressure of three atmospheres is reached, and this condition is maintained for about forty minutes, which is a sufficient period of time for the contents of the autoclaves to become reduced by the action of the steam to the consistency of a jelly. The charge is then blown out through the lower manholes into a neutralizing tank, treated with a definite quantity of carbonate of lime, and thence conveyed to the fermenting vats.

The carbonate of lime is obtained locally as an ingredient in a

species of clay, which in most peat fields is a constituent of the upper portion of the substratum immediately underlying the peat. Its presence there is due to the deposit in the past of the shells of countless myriads of aquatic micro-organisms, and it is found associated with certain phosphates, oxides, and nitrogenous compounds which serve for the prolification of the yeast in the fermenting vats, and which would otherwise have to be supplied from an outside source.

In all previous attempts to manufacture alcohol from peat, the efforts of the experimenters had been directed to the conversion of the cellulose in the charge, and the real advance made by Frestadius and Lagerheim was the discovery that there are in peat matters other than cellulose, which are saccharifiable, and from which, consequently, alcohol can be made. These matters may be descriptively termed "gums," and the important point is that the yield of alcohol from them is twice that obtainable from the cellulose with which they are associated. That such a vital fact should have been overlooked in prior experiments is due to the readiness with which these gums are attacked by the joint action of heat and acid. They saccharify much more quickly than cellulose, and when once converted into sugar they are charred if the boiling with acid is continued. In the absence of any method of accurately testing at any moment the percentage of sugar in the semi-solid peat mash, it is easy to understand how their conversion into sugar and subsequent destruction was overlooked; and, translated into practice, the departure in the new process consists in so regulating the period of digestion in the boiling vessels that the contents are discharged at the moment when the conversion of the "gums" is complete, the more stubborn cellulose remaining virtually unaltered.

When the digested peat mash is blown out into the neutralizing tanks, there is no attempt made to express the liquid part of the jelly-like mass with its dissolved sugar in order to procure a clear wash. Indeed, it is claimed that such a separation, even if it could be conveniently effected, is undesirable, seeing that a considerable proportion of the sugar formed in the autoclaves is never dissolved at all, but remains held in the fibres of the peat. Be this as it may, the practice of admitting the whole mass of the treated charge to the fermenting vats is a very desirable simplification, for it evades the difficulty which is always encountered in pressing peat free of water, which, with the alternative difficulty of finding a ferment capable of acting effectively within the interestices of the peat, had stood in the way of previous experimenters.

The yeast used in the Lagerheim-Frestadius process is a special

one prepared from a berry which is found growing on the peat fields. It has twice the efficiency of ordinary beer yeast for treating peat mash, and when the contents of the vats are subjected to its action, their physical character gradually changes as the operation of fermentation proceeds, the whole loosening up and becoming more and more fluid, until, when, the fermentation is completed, the solids separate and fall to the bottom, carrying with them the yeast cells and the nitrogenous matter which they contain. The whole operation of fermentation is conducted under more acid conditions than have hitherto been customary, and to meet this development, the special yeast is trained by special culture to resist at least 6 per cent of acidity with the result that, any impure ferments present in the mash being rendered inoperative by the excess of acid, the alcohol made is as pure as that obtained from corn.

After fermentation, the liquor in the vats, which contains most of the alcohol, is decanted, and, instead of being distilled in the ordinary way, is re-introduced into the autoclaves, together with a fresh supply of peat and acid, and steam admitted. When most of the air has been driven off, the mingled steam and air are made to pass over to a condenser, carrying with them the alcohol, the aromatic contents of the peat, and certain ethers whose formation is due to the presence of free acid in the charge. When, as nearly as can be judged, all the alcohol has been distilled, the connection with the condenser is cut out, and the autoclave connected up with the next autoclave, which has just been replenished with peat and fermented juice ready to be distilled. Any alcohol left in the first autoclave is thus saved and added to the yield of the second. The distillate is rectified in the usual way.

This method of distilling, besides being very efficient in practice owing to the large surface presented by the peat in the autoclaves, permits of two important economies, the one in the steam, which serves the double purpose of continuously digesting fresh peat while it is carrying over the alcohol, the other in the acid, a portion of which is returned from the vats to the autoclaves instead of being wasted.

It has been mentioned that the solid matter precipitated in the vats during fermentation contains all the nitrogen in the original peat, and it is of course possible to submit it to any treatment to recover that nitrogen that could be applied to the fresh material. There is however this difference between the two cases that whereas the nitrogen from the residues in the vats has been put through a cycle in which, without being diminished in quantity, it has served to feed the yeast during fermentation, the same nitrogen if extracted directly from the

raw peat performs no such duty. In one case we have fixed nitrogen *plus* alcohol, in the other simply fixed nitrogen.

Since fuel is needed for generating steam and other purposes in the process, the residues from the fermenting vats, after being dried on an inclined still to drive off any remaining alcohol, are subjected to dry distillation, and the peat gas produced is burned under the boilers and peat ovens. Of the by-products, the most important are ammonia, which is collected over sulphuric acid, paraffin, creosote, various oils, tar, and methyl alcohol. The presence of the latter is especially opportune, as it serves as a denaturing agent for the alcohol. In fact, considering the process as a whole, it is remarkable that the only ingredient that has to be imported onto the ground is the sulphuric acid used in the autoclaves and for collecting the ammonia. Everything else necessary is found on the spot or is produced as a by-product.

Coming now to the consideration of the economic side of the Lagerheim-Frestadius system, several points present themselves. First there is the matter of cost, and it is conservatively estimated that reckoning the price of sulphuric acid at $7.50 per ton, the alcohol can be marketed at a profit at 5 cents per gallon. The extent to which the price of the acid enters into this estimate may be figured on the basis that an increase of 10 per cent in the cost of this ingredient would entail an increase of 2 cents in the selling price of 40 gallons of alcohol; or, to put the matter in another way, if the price of the acid were to double, the proportionate advance in the price of the alcohol would only be ½ cent per gallon. This is in contrast to present conditions where the price of alcohol is dependent principally on prices over which the alcohol manufacturer has no control and which are the determining element in the cost price of his product.

In all manufacturing industries the proximity of the locality where the commodity is made to the market where it is sold is an important consideration. In the present case it need only be said that the situation of the peat fields, distributed as they are over the country, is at least as central as that of the oil fields; and that in the matter of transport, alcohol presents exactly the same problem as petroleum.

The yield of alcohol in the Lagerheim-Frestadius process varies from 30 to 40 gallons per ton of dry peat. As peat in the natural state contains from 85 per cent to 95 per cent of water, the yield per ton of peat as it is taken from the bog is from 3 to 4 gallons. This corresponds to about 2½ gallons of 96 per cent alcohol per cubic yard of wet peat. The yield of sulphate of ammonia is about 2 pounds per gallon of alcohol produced; and the process can be inclined to yield more sulphate or more alcohol as desired.

OBTAINING ACTUAL KNOWLEDGE OF THE COSTS OF PRODUCTION.

By F. E. Webner.

IV. USE AND ABUSE OF MECHANICAL AIDS IN COST FINDING.

Mr. Webner's series began in May, and his preceding themes have been: "What Constitutes a Knowledge of Costs?"; "When and Where a Close Knowledge is Needed"; and "The Profitable Use of Cost Comparisons."—THE EDITORS.

"WHAT is one man's meat is another man's poison" is an expression that aptly fits the matter of mechanical brains, for on every hand can be seen ill-fitting "aids" in the shape of devices which under certain conditions actually cost more to operate than the value of the time saved. By this it is not meant that such devices are without merit, but rather that what is known as good salesmanship has succeeded in installing a machine in a cost department that would be better off without it. Even such an erstwhile good friend as an adding machine can cost more than it saves, by having men killing time while waiting for one or more users ahead of them; that can be construed as an abuse of the machine in that it overloads it at too great a cost; the solution is additional machines.

The same condition obtains in the case of time recorders on individual job numbers. When workmen are required to walk too far to register, then the cost is too great and the frequent congestion about the machine makes the plan burdensome and interferes with the volume of production to an appreciable extent. The remedy is plain, though not always recognized, the trouble being most often charged against the cost department as an insuparable difficulty.

The function of the man known as the "lightning calculator," at a high rate of wages, in nine instances out of ten in this machinery age can be fulfilled by a bright boy at consistent wages, aided by a modern device which may cost anywhere from $35 to $1,000 but which probably quickly pays for itself many times over.

There are machines for adding, for multiplying, for determining elapsed time, for computing interest, for extending pay-rolls and invoices, and for almost every mathematical calculation necessary to a well organized cost department; and there are instances where by slight reapportionments of duties and the installation of mechanical

devices, the burden of expense of cost finding can be cut down and the efficiency heightened.

Users of machinery do not always get out of such machinery the maximum results, for the reason, primarily, that not enough study is put upon the matter. It is a foregone conclusion that the installation of any machine in the line of mechanical brains is going to necessitate a reapportionment of duties in order to effect any saving of time or money, as the mere act of doing by a machine what the human brain formerly did will serve only to relieve the brain but will not save any great amount of time. The act of writing down figures is not in this sense considered as purely brain work; as an example take an adding machine; if a column of figures is already on paper it is indeed a poor clerk who cannot correctly foot the column mentally, in almost if not quite as quick time as he can foot it mechanically. Now the beauty of the modern wide-carriage machine is to be able to use it primarily as a listing and recording devise, to which the adding feature is but an incident; and if the system is planned with that idea in view, then the adding machine will be a big help; but if it is not intelligently planned, it may be likened to a general in command of a corporal's squad; it is good in the lesser capacity but its fullest possibilities are not exercised.

There are several mechanical arithmetical contrivances on the market that do not print or list; therefore they are brain relievers only and cannot perform any other functions; some are very wonderful indeed in executing intricate calculations involving multiplication and division, and may be made good use of in estimating departments and in numerous other capacities—such for instance as the auditing department of large railroads, where such machines are used actually by dozens and give good satisfaction; they are not however fitted for use in a cost department except as brain relievers.

There is a new billing machine about to be put on the market which is a typewriter combined with an arithmetical machine, very different from those that have been on the market for several years. This device automatically extends prices and deducts discounts, and at the same time accumulates the quantities and extensions; it will probably work into a place of value in a cost office. There is one weakness about multiplying machines that have existed in the past—they all have needed manual assistance and none have possibilities to set the multiplicand and the multiplier as the first act and let power do the rest, but with a multiplier of say four figures the contrivance must functionate one place at a time and must either be as-

sisted to the next higher place or figure by means of the operator's hand, or the next figure must be set after the carriage has moved.

On "in and out" time reports for use on time recorders a numbering machine can be made to play an important part. There are large-sized numbering machines which have date stamps attached—the numbering feature being used to put the workmen's numbers on consecutively in large clear figures, while the dater puts the period-ending date on each card. These numbering machines perhaps do not save a large volume of time, but they make a uniform series of cards in a short space of time and they make no mistakes—which counts for considerable. By the use of certain other modern devices, the "in and out" time and the numbering machine just mentioned can be dispensed with and replaced by a form of job ticket which can be used for pay-roll computations as well as charges against individual shop-order numbers. Such a job ticket is made on the perforated-coupon plan, by means of which each separate shop order can get its proper charge and the coupons for a given shop-order number can be detached and filed under such number and become subject to ready reference. A stub containing the totals can be filed under the workman's number and held there until the payroll is made up, at which time all the cards therein can be removed and summarized on an adding machine for the pay-roll. The plan for recording the time on the coupons is to use a time stamp for the starting time and finishing time of each job during the day; the number of coupons in the strip can perhaps vary so as to fit the needs of different workmen—some may complete six jobs in a day while other men may have longer jobs and use perhaps not more than two coupons a day. When the entire day's work is recorded on the one strip it is hardly necessary to require the "in and out" time at the factory entrance or elsewhere, as the first and last time impression on the day's time report will answer the purpose.

The great bugbear of any cost system is the usually enormous amount of figuring on time tickets; it is not profitable or advisable to attempt to make book-keepers of shop hands, and if the class of help employed in a given shop is illiterate, then with the use of modern accounting devices the shop hands can in a way act as automatons and accomplish the desired results. A child can learn how to stamp with a time stamp and the average workman has no difficulty in that respect—sometimes though they learn how to abuse the stamp by unnecessarily hard blows upon it, which actions should be summarily dealt with when discovered. With a time stamp or recorder the workman has hardly to think, as it becomes purely mechanical to

record the time and it lays it upon the cost department to reduce that time record to a comprehensive statement of labor values. Formerly that was a matter of considerable moment; latterly however mechanical brains can be used; there is a device for taking care of such time reports, the operator setting on it the workman's rate of pay per hour, also setting on it the starting time and the finishing time as shown on the time report, and by the turning of a wheel printing upon the coupon the number of hours and minutes elapsed and the exact money value—truly a wonderful invention. Its functions do not end there; the machine has a tape equipment upon which is recorded every time ticket computed, and when a total thereof is desired the turn of a lever prints a total of time consumed and a total of the labor cost involved. This machine in connection with the time recorder is perhaps the most important in use in a cost department; by its means the work of several clerks is accomplished by one low-priced clerk. Totals of time of a given workman for the day; totals of all workmen on a given order number; all workmen in a department or all departments in the factory can be accumulated.

There are a number of clever devices on the market for computing pay-roll extensions, and where pay-rolls are made up from "in and out" time these are labor savers; the differences between the several devices of this kind are purely mechanical, and all or nearly all perform practically the same operations. There is one pay-roll machine in particular which has the additional feature of computing elapsed time and also earnings under a premium system. This is accomplished by means of an indicator for setting the time of starting on the work and one for setting the time allowed for the job; by reference to the finishing time can then be seen, directly opposite, the amount of time elapsed and the money value at the man's rate per hour, also an additional amount equal to ½ of the time saved.

Where certain cost clerks, through constant practice, have become veritable computing machines it often happens that mechanical devices will not save those men enough time to be worth while to change the existing systems. If the lightning calculator employee can be replaced by a less expensive man and a machine, then it may be worth while. While corporations are said to have no souls, sometimes we see cases where faithful men are retained in positions for effect rather than for cause, and it may be such desired effect that will keep out the mechanical brains temporarily; but when the higher priced faithful men have passed to their reward, then the easiest way of filling the vacancy is more than likely the less expensive man and the machine with no prejudice to overcome.

JAPANESE FACTORY HANDS AND LABOR CONDITIONS.

By M. Kawara

Mr. Kawara's review of the Japanese iron industry will be well remembered, and has been widely quoted. His present topic is even more actively interesting, because so closely associated with the greatest problem perplexing Western employers.—THE EDITORS.

SOCIAL conditions in Japan are drawing nearer to those of the West each year, bad as well as good characteristics of the nation being either consciously or unconsciously discarded. Naturally the changes are slowest in the lowest strata of society. The majority of the laboring masses are still governed by the old ideas and customs, but some workingmen are quite westernized, conspicuous among the latter being iron workers. This is very natural, since modern iron industry is strictly of western origin. The iron workers wear European clothes while in the shops, use the inch and foot or the metric system as the standard of measure, call the tools by English or French names, Japanized of course—hammer is "hama," scraper "sikarap," wrench "suppana."

The changes are not limited to superficial matters alone. The attitude of the men toward their employers is also entirely westernized, and the corresponding changes on the employers' side are also apparent. The old relation of master and servant, which works beautifully if the employer is considerate and the employed obedient, is gone, and the friction between capital and labor is well under way. We no longer see a good-hearted employer going from house to house of his employees to see if the families are well provided for, or the employed flocking to their employer's mansion to do whatever they can, not for any compensation, but simply to please their bread giver. Instead, nowadays we often hear men talk about strikes because their employer refuses to raise their wages to a reasonable amount, or because they are subjected to oppressive measures, etc., precisely in the same manner as the workingmen talk in the occidental countries.

For bringing about this hostile attitude the workingmen alone cannot be blamed; the capitalists are responsible in a large measure. The latter naturally try to get as much work as possible out of their employees at the smallest wages at which they can retain the workers.

Of course there are exceptions. Some capitalists are very considerate toward their men, notably those who own small establishments, in which all connected with the works become quite intimate. Here each party respects the interests of the other, resulting in mutual benefit. However, taken as a whole, the relation between employers and employed is far from satisfactory. Therefore, the united efforts of the latter are necessary in order to guard their interests.

The movement to organize labor associations, like those found in the Western countries, was started among the iron workers some ten years ago by men who proved later to be radical socialists. At first the movement seemed to be eminently successful, but within a year or two the enthusiasm of these leaders cooled down and, moreover, careless utterances of these men brought about the determined opposition of the government and the conservative elements of the nation. It was very unfortunate from the workingmen's standpoint that they gathered under the leadership of these men who were sure sooner or later to incur the displeasure of practically all classes. Conditions would have been quite different from what they are now, if both the workingmen and leaders had been more prudent.

The original leaders, who seem to have set themselves to this work merely to use the organizations as stepping-stones to get into the politics of the nation or, at best, to further their socialistic propaganda, began to desert the ranks of the workingmen when the latter realized the disadvantages of relying upon men who had a different end in view from that at which they themselves aimed. From this on there were many changes. Suffice to say that the percentage of men enrolled in the organization is very small, and that it is inefficient as the means of protecting and furthering their interests. There are two points to be noted in this connection: first, they exert their best efforts toward mutual assistance in cases of sickness of and accidents to their fellow-members, and establishment and improvement of co-operative stores; second, they do not meddle with politics.

The labor organizations in the West seem to be opposed to industrial schools and the apprentice system. This is not the case in Japan. Some fifty schools, training young men and boys in the arts of different trades, are receiving hearty support from all classes of people. At present men from these schools are few in number, because the schools are of recent origin. Nevertheless, they promise to furnish the best kind of help. Far the greater proportion of boys are trained by large establishments and by individual workingmen. In most factories regular courses are given. In the day time boys

are assigned to simple work under the care of skilled workers, and at night lessons in mathematics, drawing, English, etc., are given. The wages paid to these lads are small, being not quite enough to support them. The individual apprentice system is quite different. A highly skilled artisan can take in boys under his exclusive care, and train them according to the ways he sees fit. He usually furnishes them food, clothes, and lodging, and even a little pocket money on holidays. Of course the wages the boys earn go into the master's pocket. When a youngster has spent several years in this way, he becomes a full-fledged artisan and can work independently.

Much has been said about the inefficiency and the lack of sense of responsibility among Japanese workingmen. As far as I can see there is no justification for the former accusation. I have seen men work both in Japan and in America, and failed to find any difference as to the quantity and quality of work done. There are several Japanese machinists in the Union Iron Works in San Francisco, California. All who have seen them work declare that they can do just as much as the average Americans. However, there is one exception—that is, the muscular strength of the Japanese is much less; hence for work that requires sheer physical strength the latter are far less efficient. As to the second point, viz: irresponsibility, I cannot say much for them. When I was working as a draftsman in a large government arsenal in Tokio, the fellows there used to pride themselves upon loafing as much as possible without being detected by the engineers in charge. Several times I saw a young man draw a line or two and no more in a whole day. In this plant it was not uncommon to find men sleeping on the bridges along the line shafting. It should not be understood, however, that such occurrences are frequent in commercial shops. In some of the latter establishments the shop organization is such that men have to work hard, and they do work hard.

What has been said is based on what I have observed among the iron workers; still, these general statements apply to all classes of working people with little if any modification. To sum up: (a), Western ideas and methods are finding their way among the Japanese workingmen, foreshadowing the troubles experienced elsewhere between labor and capital; (b), the Japanese workingman can do just as much work, if provided with proper means, except work in which physical strength is of prime importance; (c), when men are treated as men, and not merely as a sort of intelligent machine—in other words, when men are made to feel their responsibility—they perform their duties quite satisfactorily.

EDITORIAL COMMENT

The Freight-Rate Question.

THE sufficiency of existing railroad rates or the expediency of raising them, is a question upon which experts differ widely. There are few indeed, who are so strong masters of the facts and conditions that their dogmatizing on the subject would be anything but rashness. James J. Hill's achievements surely entitle him to foremost place among these few—"the greatest railway economist in the United States," a leading financial authority calls him, "whose early conceptions of cardinal principles of railroad operation have made the operation a science." Naturally, Mr. Hill's uncompromising advocacy of an immediate advance in freight rates has been widely noticed and is quoted with almost sensational effect. With Hill and Harriman—giants both in this railway world of giants—crying for the affirmative, who shall argue the negative?

But, after all, an argument is no stronger than its premises and its logic, whoever makes it, and Mr. Hill explains his position by figures and comparisons which any one may test for himself. Briefly, he states that unless the railroads "secure an advance in freight rates, they will be unable to expend the $600,000,000 or so a year for new rolling stock and facilities;" that this stoppage of outlay will react as a direct loss to manufacturers, producers of raw material, farmers, lumbermen, mechanics, laborers, and the people generally; that the railroads themselves will decay, and "all else will decay with them," for the railroads "by their large expenditures have given prosperity to the manufacturers and the people." And the advance in rates which would avert all this he says "is a mere bagatelle." It is strongly reminiscent of "all for the loss of a horseshoe nail." Recent bond sales suffice to show that railroad credit is at no such desperate ebb at present; and the things that have discredited railroads in the past have not been undercharging for freight or overpaying labor.

Now Wall Street is thoroughly familiar with the figure of the inverted pyramid, and knows better, probably, than any engineer or industrial manager how safely the enterprise of expending $600,000,000 a year could be based on "a mere bagatelle" of prospective increase in gross earnings. To an average man the position would seem unstable, and a plan affording broader foundations would appear less likely to lead to that dangerous "prosperity" of inflation which Mr. Hill himself has so keenly dissected. But perhaps the bagatelle of increased freights is intended to be larger than the term would suggest. In the case of the Pennsylvania Railroad alone, as the *Journal of Commerce* points out, it would amount to about $22,000,000 a year. If we increase the burden of transportation charges which all materials and products of husbandry and industry must bear, it can hardly fail to affect their consumption, to some extent at least— to reduce the business which producers, manufacturers, farmers, mechanics and laborers can do—the tons they can ship or the miles they can travel; and then we shall have shrinkage of railway income again in a yet more vicious form. The people are no more dependent on the railroads for prosperity than the railroads are on the people.

The natural presumption would be that an intricate structure such as the present system of freight rates, evolved over a long period of years by the constant influence and interplay of opposing forces, must be pretty near to its true balance of position. A horizontal marking up of the whole scale is manifestly a

grave economic proposition. It savors strongly of those artificial operations which usually result in dislocation and greater distress.

Mr. Hill seems to feel this, and he makes certain comparisons with foreign conditions which appear to him to justify his views. American roads, he says, (the interview is signed and presumably is correctly reported) cost from one-half to one-fifth as much as those of other countries, carry nearly double the business per mile, pay double the rate of wages, and charge rates one-half to one-third as great.

Considering the enormous relief from fixed charges due to their low comparative cost, and the great advantage of more active use of the invested capital (the quicker turnover, so to speak) given by the double business, it would seem *prima facie* a fair deduction that American roads could and should pay higher wages and charge lower rates in the proportion stated, and still be at an advantage in net earnings. And we are yet more strongly inclined to this opinion when the very great difference in character of most of the service is taken into account. A heavy weight in the American average is carried by the figures for low-class, long-haul business, loaded, unloaded, and even made up into trains and handled at terminals by shippers and consignees, with a minimum of relative cost to the railroad company and a maximum of simplicity of service required from it. A very heavy factor in European business, on the contrary, is short-haul, small-load and parcel business, handled almost from door to door, with a maximum of labor and of complexity of service. Further, this business abroad is performed with a celerity and a security undreamed of here.

After all, this is the thing that shippers and receivers value—reliability and speed in the movement of freight from siding to siding or from platform to platform—from the point where the sender leaves it in the railroad's care to the point where the consignee can pick it up again. Of this, the time needed for movement over the open road is but part, and often a very small part; but this is the part upon which a wholly disproportionate amount of attention has been concentrated by American railroads. Huge locomotives and train loads permit a cost of carrying which, expressed in mills per ton mile is wonderful in its cheapness; but then we handle our magnificent cars so badly that in normal times they are not in motion on the average two days a month, and in seasons of peculiar congestion they do not total in their movement a mile an hour. The rest of the time they are standing in congested yards, delayed at transfer points, inaccessible on sidings, lost through errors, under repair because of needlessly frequent and rough handling—and meantime shippers and merchants suffer. In short, our progress is sadly unbalanced. In equipment and rolling stock it is most impressive; in permanent way it is indifferent; in efficiency of traffic management it is practically nil. The inefficiency in this department, overloaded to the breaking point by the existing car equipment, would be worse and not better if a large addition were made to the rolling stock in service, because it would increase the congestion which present systems of management create.

The extravagance and waste of average American railway management is on the dawn of correction. Some excellent work in the reduction of expense for fuel and stores and in the more economical maintenance of equipment has been begun. But in the inefficiencies of traffic management there is a field of possible savings so large that when the roads begin to realize them, raising freight rates or reduction of wages will appear insignificant in comparison. The solution of bettering the railroads' credit lies not in getting more money from their patrons or distributing less to their employees, but in saving that now lost through their own inefficiency.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE VENTILATION OF FACTORIES.

A REVIEW OF THE GENERAL PRINCIPLES AND METHODS FOR THE REMOVAL OF DUST AND FUMES.

Dr. J. S. Haldane—Royal Society of Arts.

THE removal of dust and fumes, often a most important and difficult problem in factory ventilation, was the subject of the fourth Shaw Lecture on Industrial Hygiene, delivered by Dr. J. S. Haldane before the Royal Society of Arts on February 27 and published in the *Journal* for May 22. This is a subject on which Dr. Haldane can speak with authority, on account of his connection with the work of the late Home Office Committee on Factory Ventilation. It is impossible here to reproduce the many practical illustrations he gives of the principles laid down in his paper but the following abstract giving the main points of his general review of principles and methods will be found of interest.

"Whether or not any variety of dust is known to cause dangerous effects when habitually inhaled, I think that every kind of dust produced in manufacturing process ought, as far as practicable, to be prevented, or removed from the atmosphere in which the workpeople are present. The reason for this is not only that dusty air is, at the best, unpleasant to breathe, but that when dust is present the clothes, skin, and hair become very dirty, untidy, and uncomfortable. This inevitably tends to lower the social status and self-respect of work-people, if, at any rate, they have to go back to their homes in the same untidy condition. When dust and dirt cannot be avoided the provision of overalls, or of means of washing and changing clothes on leaving work, is extremely desirable. . . .

"Apart from the reasons which I have just referred to, it is often urgently necessary, on the score of health, to prevent the inhalation of dust. Certain kinds of dust, when constantly inhaled during work, produce in time most disastrous effects, and we may pretty confidently say of every kind of dust—that it is to some extent harmful."

Of dusts which are definitely harmful, a very important class is that from the disintegration of hard stone or other material. The dust produced in mining hard rock or in stone dressing, the flint dust used in the pottery trade, the dust from dry grinding in the metal trades, and the steel dust produced in file cutting and other work are most harmful in their effects. Striking evidence of the disastrous effects of the inhalation of hard rock dust is given in a table showing the death rate of Cornish miners, 94 per cent. of whom die of lung disease at an average age of 37. Other dangerous dusts are those from poisonous materials of any kind, particularly from lead compounds. Dusts from textile materials are less serious in their effects and coal and cement dusts seem to have but little influence on the health of workers. Fumes

from chemical processes and poisonous gases are always dangerous and should not be allowed to escape into the room at all.

"In many cases the best way of dealing with dust is to prevent its formation altogether. This can be effected by substituting wet for dry processes, and fortunately much of the most dangerous dust can be dealt with in this way—in particular the dust from disintegration of hard stone or steel. Thus the use of a jet of water prevents dust formation in rock-drill and other work in tin and granite mining, special rules to this effect being now in force. It is to be hoped that in all cases where dust from disintegration of hard stone, fire-clay bricks, and similar material, is apt to be inhaled, wet methods will also be adopted where possible. The substitution of wet for dry grinding, and for dressing of grindstones is another important step in the right direction, and I have little doubt that in many other dusty processes it would be practicable to use wet methods, though, unfortunately, wet processes are quite out of the question in very many cases.

"When dust formation cannot be avoided, its escape can sometimes be prevented by entirely boxing-in the dusty process. Where the dust is itself the product of the process, as in the grinding or breaking up of material, efficient boxing-in is an advantage to the process itself as well as to the persons employed in it. Where the dust is in other ways of some value, the same consideration applies. The use of dust-proof arrangements for filling and conveying dusty material, particularly where the dust is poisonous or otherwise dangerous, is a further advance in the same direction. By means of simple mechanisms for this purpose much dust-inhalation and loss of material may be prevented.

"In processes where fumes or noxious vapours are emitted closed vessels ought also to be used wherever possible, and if a closed vessel, or a boxed-in machine, is also connected with an exhaust pipe the fumes and dust are prevented from escaping at times when the vessel or machine has to be opened.

"In most cases it is unfortunately not possible either to prevent the formation of dust or to box in the dusty process completely, and the only method available is to draw away the dust by means of an air-current. There are certain general principles applicable to the removal of dust in this way. In the first place the dust ought to be removed at, or as near as possible to, the point of origin. The advantages of this are evident; by this means the dust is prevented from getting into the general atmosphere of the room and being inhaled by those present, as well as settling everywhere. A far smaller volume of air is also sufficient to remove the dust. This is important, not only from the point of view of expense, but because draughts and cold are also prevented. When dust is permitted to get into the general atmosphere of a factory, enormous volumes of air are required to carry it away, which means that equal volumes have to come in from outside, so that warming or prevention of draughts may be quite impracticable.

"A second general principle is that the air current from the source of dust to the exhaust opening should, as far as possible, envelope the source of dust, and be of sufficient velocity to carry the dust with it in spite of the ordinary slight draughts existing in the room, or produced by the dusty machine. It is unfortunate that in whatever direction an exhaust opening may point, the air entering it is sucked in from all sides. Hence the linear velocity of the draught towards the opening diminishes very rapidly with increasing distance; and at a distance of two or three feet an exhaust opening, unless very large, will fail to carry off dust efficiently, particularly from a machine which itself causes draughts. . . . An air current from an inlet can be directed from it, owing to the momentum of the moving air, but not a current to an outlet. The source of dust has therefore to be enclosed, as far as possible, by hoods or other coverings, to serve as air-guides. When a dusty machine can be enclosed on all sides, except where the material enters or leaves it, a very satisfactory result can be ob-

tained. Where such enclosure is not possible, the best that can be done is so to arrange the inlets and outlets of air to the room that the dust is on the whole carried directly towards the outlets. A further important principle is, that as all dust tends to fall, it is often best to remove it in a downwards direction. This applies particularly in cases where the air-current carrying the dust towards the exhaust opening is very slow.

"It must not be forgotten, finally, that when exhaust ventilation is used for removing dust, provision must be made for corresponding inlet ventilation to the room, the air being warmed, if necessary. It is not uncommon to see exhaust ventilation rendered partially inoperative by failure to provide proper inlets.

"In producing an air-current along a duct we are imparting motion, and therefore energy, to a large quantity of gas. The amount of energy thus imparted—in other words the work done upon the air—varies in proportion to the mass of air moved and the square of its velocity. In the case of an air-current in a duct, however, the mass moved varies directly as the velocity. Hence the total work done will vary as the cube of the velocity of the air-current, measured at any one point in the duct. The work done on the air is also proportional to the mass of air moved multiplied by the pressure it is moved against, hence this pressure is proportional to the square of the velocity. Bearing these facts in mind we can readily understand the more important considerations relating to the proper arrangement of air-ducts.

"It is evident, in the first place, that the greater the sectional area of an air-duct is, the lower the velocity at which a current of a certain number of cubic feet per minute will pass, and consequently the less work (in proportion to the square of the velocity) will be needed to move it. There is, however, little advantage in increasing the cross-section of a duct to much more than the cross-section of the fan opening, as additional velocity would then have to be given to the air as it passed through the fan, with corresponding increase in resistance. Nor would it, as a rule, be an advantage to increase the size of the fan so as to permit of a low velocity through it, as in such a case the current is easily reversed by wind. The space occupied by the ducts and fan is also a material consideration. Any obstruction or narrowing in a duct will correspondingly increase the velocity, and therefore still more the resistance, so that all obstructions should be avoided, including those due to deposits of dust. Any sharp bend converts into heat the energy of motion possessed by the moving air, and an equivalent quantity of energy of motion has again to be communicated to the air beyond the bend. A sharp bend may thus double the resistance, and ought to be avoided if possible. A gradual bend causes much less extra resistance. A further factor in causing resistance is friction of the air along the sides of the duct. With the comparatively short and smooth ducts commonly used in factory ventilation, this factor is, however, small, and need scarcely be considered.

"Roughly speaking, the cross-section of the duct or its combined branches should be about equal to that of the fan opening; and if a centrifugal fan, capable of overcoming considerable resistance, is used, the duct may be much smaller, and the air-velocity in it much higher, than if a propeller fan is used. A propeller fan can only work against small resistance, while a centrifugal fan is adapted for much greater resistances. On the other hand, the horse-power required for the centrifugal fan is greater, in correspondence with the greater velocity of the air-current and consequent greater resistance.

"An important matter is the arrangement of branch ducts leading into the main duct connected with a fan. In exhausting dust-laden air from several dusty machines or dusty work-places, a corresponding number of branch ducts are required. If they are not properly arranged the amounts of air passing along the different branch ducts will differ considerably, so that at one place the exhaust current is too strong, and at another too weak. Unnecessary resistance may also be caused." Dr. Haldane describes experiments made by the

Home Office Committee to determine the best arrangement of branch ducts. The Committee found that "the loss of power at the junctions, and at the same time the tendency to inequality in flow through the branch ducts, may be avoided by the simple expedient of making the branch ducts join at a slant."

The concluding part of Dr. Haldane's paper deals with the relative merits of propeller and centrifugal fans for the removal of dust and fumes, and gave a number of illustrations of the application of the principles laid down to special cases. In concluding he referred particularly to the method of increasing the effectiveness of exhaust openings by blowing air towards them. Though the system involves the provision of two fans there are many cases, he thinks, in which the method could be successfully and economically used.

THE EXTENSION OF THE KAISER WILHELM CANAL.

NOTES ON THE PROPOSED ENLARGEMENTS AND THEIR ESTIMATED COST.

Engineering.

THE unexpected increase in the dimensions of ships in the last few years has made the enlargement of many canals an imperative necessity. This result of modern developments is nowhere more strikingly illustrated than in the case of the Kaiser Wilhelm Canal, which, though it has been in service only twelve years, is now much too small to accommodate the modern ships of the German merchant marine and especially the ships of the new German Navy. A project for its enlargement has recently been put forward by the Government, of which we take the following details from *Engineering* of May 29.

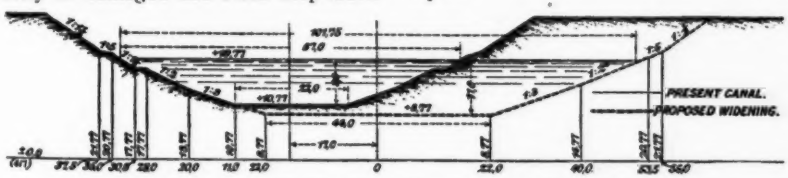
"The traffic of the canal has grown very materially during the twelve years it has been open, though not exactly on the lines anticipated, and the canal must be said to be at present taxed almost to the full of its capacity. The original calculation upon which the undertaking in question was based reckoned upon an annual traffic of 18,000 vessels, with an aggregate tonnage of 5,500,000 registered tons. The number of vessels was exceeded as early as 1896 (19,660 vessels), but, to begin with, the aggregate tonnage fell very much short of what had been expected, inasmuch as it was only 1,848,458 registered tons in 1896. Ten years after the opening of the canal (1905) the calculated tonnage was, however, not only reached, but surpassed (5,749,949 registered tons), and the number of vessels that year rose to almost twice the calculated number—viz., 33,147. Although the size of the vessels had grown about in the same proportion as their number—that is, it had nearly been doubled during those ten years—it is interesting to note that large vessels, on the whole, were rather shy of the canal, and that the traffic of deep-draught vessels has not increased at anything like the rate at which the traffic of smaller vessels grew.

"At the time of drawing up the original plan for the canal, the maximum dimensions of vessels for the Baltic trade were held to be 145 metres long, 22 metres broad, and 8.5 metres deep (477 feet by 72 feet by 28 feet). Only in odd years have there been more than fifty vessels between 26 feet and 28 feet draught. The above maximum measurements were not considered as likely to be much exceeded, and the dimensions of the locks were based upon them, inasmuch as their length was 150 metres, their breadth 25 metres, and their depth 10 metres, with the average canal water-level at Brunsbüttel (the western entrance), and with 9.5 metres at Holtenau (the eastern entrance). The present lock dimensions, it will be readily understood, are altogether inadequate. The breadth of some of the largest steamers now afloat exceeds that of the locks, which likewise— and this is of more vital importance—are incapable of accommodating the new large types of German warships.

"The extensions and alterations of the

canal comprise the construction of two new main locks, both at Brunsbüttel and at Holtenau. Local conditions and other considerations make it necessary that these new locks should be built close to the old, at Brunsbüttel on the northern, and at Holtenau on the southern side. In order to ensure a quick and safe passage for large ships at any time, it is necessary in fixing the dimensions of these two new locks to have regard to the size of vessels which in the future will require to pass the canal. The length between the gates will be 330 metres (984 feet), their breadth 45 metres (147 feet 8 inches), and their depth 13.77 metres (45 feet) below average canal water-level, which is the same as average level of the Baltic. With comparatively low-water level the locks will still have a depth of 12 metres (39 feet 4 inches). It is pointed out that the depth is of special importance at the Brunsbüttel lock, inasmuch as it, on account of its vicinity to the mouth of the Elbe, will facilitate the bringing into safety of damaged and often deep-laden vessels. The depth of the Holtenau lock might, perhaps, have been a little less, but it was deemed advisable not to make it so, considering the extent to which the canal will be deepened. The proposed dimensions of the new locks compare favourably with the locks of other large canal undertakings. Against the 330-metre length and 45-metre breadth of the new North Sea-Baltic Canal locks, those of the Panama sea-level canal are only planned at 305-metre length and 30.5-metre breadth; next come the proposed Antwerp locks, with respectively 300 and 35 metres; the proposed Wilhelmshaven locks, with 260 and 35 metres (to be widened up to 40 metres); and the proposed Bremerhaven, measuring 250 by 35 metres.

"The enlargement of the section of the canal, both as regards width and depth, will appear from the accompanying section; the depth beneath ordinary canal-level will be increased from 9 to 11 metres (29 feet 6 inches to 36 feet 1 inch), and the bottom breadth of 22 metres (72 feet), at 9 metres depth, will be increased to 44 metres at 11 metres depth, which means an increase of surface breadth from 67 to 101.75 metres (220 feet to 334 feet), and of sectional area of water from 413 to 825 square metres. These measures will allow of the high-level bridges at Grünenthal and Lewetzau being preserved, in spite of their comparatively slight foundation depth. Should a still greater depth of the canal section—say to a depth of 13.50 to 14 metres (44 feet 4 inches to 46 feet)—afterwards be decided upon, this can be brought about without a material increase in cost. This would, however, necessitate the building of two new high-level bridges, unless their foundations were carried to a sufficient depth."



PRESENT AND PROPOSED SECTIONS OF THE NORTH SEA-BALTIC CANAL.

Deviations from the present course of the canal will be necessary in only two places, where curves of small radius interfere with navigation. The total deviation will amount to about three miles. The number of passing places will be increased from eight to eleven. Four of these will be constructed as turning places, with 300 metres diameter at the bottom and 340 metres diameter at the surface. The length of the passing places will vary from 600 to 1100 metres.

"The crossings of the canal by railways and roadways comprise high-level railway crossings on the Neumünster-Heide line at Grünenthal, and the Kiel-Flensburg line at Levensau. Swing-bridge railway crossings occur at the Elmshorn-Tönder line at Taterpfahl

and the Neumünster-Schleswig line at Rendsburg. Of other swing-bridge crossings there are the Westerrönfeld-Rendsburg road at Rendsburg, and the Kiel-Holtenau road at Holtenau. The railway swing-bridges are rather a serious obstacle and danger to shipping, inasmuch as the railways have the prior right of the road. Large vessels are apt to get beyond control when they have to pull up, and experience has shown that the consequences may be rather serious. The loss of time is also to be considered, and may occasionally amount to as much as half-an-hour, and there is no chance of making up for this loss of time, as there is a fixed maximum speed. It is more especially the navy that suffers from this inconvenience, and on a squadron passing through the canal the aggregate loss of time may amount to several hours. It is therefore considered necessary to make the canal and the railways entirely independent of each other, and as tunnels are not expedient, it is proposed to carry all the railways across the canal on high-level bridges, the lower edge of which will have a length of 74 metres, and a height of 42 metres (138 feet) above the level of the water. Of the present two high-level bridges, the one at Grünenthal complies with these demands, whilst the one at Levensau is only 38 metres long at the stipulated height of 42 metres. With some alterations the present Levensau bridge, however, is considered adequate for the time being. The swing-bridges at Taterpfahl and Rendsburg would in any case have to be replaced by other bridges, as the increased breadth of the canal forms a technical obstacle to their maintenance, and the building of high-level bridges has been decided upon at both places. At Taterpfahl the natural conditions do not present any difficulties, only the land is very flat, and this will necessitate the removal of the stations on either side to a place further distant from the canal: on the south side about 2 miles, and on the north side about 1½ miles, as the railway will pass the level of the present stations at a height of respectively 20 and 18 metres. Whilst the number of trains per day is about 25 at Taterpfahl it rises to 65 trains crossing the canal at Rendsburg, which fact makes a high-level bridge there still more desirable. The bridge will be located in the Osterrönfeld district, and the line will then be carried in a loop to the present railway station at Rendsburg, which there will be no necessity to remove. The present Osterrönfeld railway station will have to be abolished, and in its place a ferry across the canal will be established, which will shorten the way to the Rendsburg railway station. The ascent to the high-level bridge will extend over some 6 or 7 miles on each side, on account of the low-lying land; the portions nearest the bridge will be constructed on iron viaducts."

Another high-level bridge will be built at Holtenau and a swing bridge at Rendsburg, the canal here having the prior right of way. Other alterations and new structures made necessary by the widening of the canal include the rebuilding of thirteen locks, the relocation of seven loading places, an extension to Kiel harbor, and the removal or enlargement of several naval and industrial establishments.

"The cost is calculated at 221,000,000 marks, or about 11,050,000*l.* It has been objected that a great part—in fact, the greater part—of this large sum could have been saved had the canal been planned originally on lines similar to those now adopted; but this does not hold good. The saving in that case might have amounted to 2,000,000*l.*, or, perhaps, 2,500,000*l.*, so that the canal, if built in the first instance with the dimensions which are now deemed necessary, would have cost some 8,500,000*l.* more than was actually the case. As the canal, even if built on those larger lines, would hardly have yielded a materially bigger revenue than has been the case, the interest on the increase of the original cost during the fifteen years that have elapsed since its completion would have swollen the cost by another 5,000,000*l.*, so that the present extension in reality means a very considerable saving, of more than 2,000,000*l.*

"The total cost of the proposed extension amounts, as already stated, to about

11,050,000*l.*, to which may be added an additional item of 50,000*l.* for fortification work. It is proposed to raise the necessary funds by loan. The increase in the annual working expenses of the canal, after the extension, is not expected to exceed 20,000*l.*, and this sum is about covered by the surplus of the present revenue, reckoning the future working expenses. It is calculated that the extension can be completed in the course of seven or eight years, and whilst the work proceeds care will be taken to subject the traffic to as few interruptions as possible."

The estimated cost is distributed as follows: acquirement of land (2300 hectares), 560,000*l.*; excavation (99,570,000 cubic metres), 3,990,000*l.*; protection to the canal sides, 235,000*l.*; harbour and lock construction, 3,437,500*l.*; bridges and auxiliary structures, 1,745,000*l.*; buildings, 30,000*l.*; shops, docks, boats, etc., 75,000*l.*; engineering and administration, 125,000*l.*; workmen's barracks, sick funds, insurance, etc., 60,000*l.*; sundries, 692,500*l.* These are the principal items in the cost sheet. The remainder of the total estimated cost is intended to cover unforeseen contingencies.

THE FIXATION OF ATMOSPHERIC NITROGEN.

NOTES ON THE PRODUCTION AND UTILIZATION OF CALCIUM CYANAMIDE.

Dr. Albert Frank—The Faraday Society—Engineering.

WE have several times drawn attention in these columns to advances in processes for the fixation of atmospheric nitrogen, the last occasion being some two years ago, when we reviewed a paper by Prof. K. Birkeland, read before the Faraday Society, on the production of artificial nitrates by electricity. On June 9 last, a paper on another process, the fixation of nitrogen in calcium cyanamide, was read before the same society by Dr. Albert Frank of Berlin. This process has within recent years become of great economic importance and has taken rank among the most successful solutions of the problem. We take the following details of Dr. Frank's paper from an editorial review in *Engineering* for June 12.

"The process, on which Dr. A. Frank lectured, has been worked out since 1894, when Thomas L. Willson and Bullier and Moissan first made calcium carbide on a large scale; by Professor Adolph Frank, the lecturer's father; by the lecturer, and Dr. N. Caro. Frank and Caro, in 1895, first tried to fix the nitrogen by calcium (or barium carbide) mixed with sodium carbonate; the mixture absorbed nitrogen—isolated from the air—when heated up to 700 or 800 deg. Cent. They hoped thus to produce barium cyanide—Ba $(CN)_2$, from which they wished to prepare potassium cyanide, wanted for the extraction of gold, and other compounds. They noticed that part of the nitrogen was, indeed, bound as cyanide, but another part in the more complex form of barium cyanamide ($Ba\,CN_2$), the latter reaction being $Ba\,C_2 + 2\,N = Ba\,CN_2 + C$; that is, the carbide yields some cyanamide and, further, carbon. The ratio of the two products, cyanide and cyanamide, was about 2 : 3, 30 per cent. of the former and 45 of the latter being produced, the remainder appearing as carbon and barium oxide. Why the barium cyanamide with the formula $Ba\,CN_2$ should be more complex than the cyanide with the formula $Ba\,(CN)_2$ may be less manifest to the engineer than it is to the chemist. The lecturer and Caro subsequently observed that calcium carbide—of course, a cheaper product than barium carbide, as its raw material is limestone, in addition to coal—would, without any additional flux, yield nothing but calcium cyanamide. That was a step in advance, because the separation of the cyanide—for which we possess other sources—from the cyanamide would have been awkward. Then Messrs. Frank and Caro, together with Messrs. Siemens and Halske, and the Deutsche Bank, of Berlin, founded the Cyanid Gesselschaft, of Berlin, and the

chief question was to utilise the new product, the calcium cyanamide, or Kalkstickstoff, for which recently the term 'nitrolim' has become customary.

"As the cyanamide yields ammonia when treated with water, one application was at once found. The process, Dr. Frank explained, was technically carried out by spreading the nitrolim on trays and passing steam up the towers in which the trays were fixed, the one above the other; the resulting ammonia was absorbed by sulphuric acid to form ammonium sulphate. The same decomposition into ammonia and calcium carbonate (limestone) took place very slowly in the soil; the ammonia was absorbed and bound by the mould, and not likely to be washed out by rains. The nitrolim thus proved a valuable fertiliser, and one, moreover, which had after-effects, the second crops profiting from the nitrogen not absorbed by the first. . .

"The other applications, Dr. Frank continued, were not less important. By fusing the cyanamide with suitable fluxes, a product known as 'surrogate,' and containing 25 per cent. of cyanide of potassium, was obtained; this product could be prepared on the spot for ore extraction. The cyanamide was also a raw material for many chemical products, including prussiate of potash, urea, the guanidines, and dicyandiamide $(CN_2H_2)_2$. The latter had proved a good 'deterrent' for lowering the temperature of combustion of high explosives; it liberated its 66.6 per cent. of nitrogen when burned together with cordite and smokeless powders, diminished the corrosion of the barrels, and suppressed the flash at the nozzle. This statement was confirmed by Mr. Walter Reid, F.I.C., of London, who has investigated this effect, and who pointed out how remarkable it was that the same apparently inert nitrogen which was the active constituent of so many explosives should also furnish us with compounds which restrained the high temperatures accompanying these decompositions. The dicyandiamide was, in fact, almost too effective in retarding explosions. Another application of interest to the engineer, mentioned by Dr. Frank, was the use of 'ferrodur,' a mixture of calcium cyanamide and certain fluxes for case-hardening and tempering iron and steel; the hardening penetrated to an extraordinary depth.

"The calcium cyanamide, as turned out of the furnace, is a substance looking in lumps like a slate-coloured limestone. It is ground up to a powder, and transported in sacks lined with paper, to keep out the moisture, which would make it expand without causing any loss of nitrogen, however. Crude nitrolim contained from 57 to 63 per cent. of pure cyanamide, as much as ammonium sulphate, in addition to 20 per cent. of lime, 14 per cent. of carbon, and 8 per cent. of silica, iron, and alumina. About the manufacture, Dr. Frank could, unfortunately, not give much information of technical value; he hoped to do so in a few months. The carbide coming from the electric furnaces was transported over to the cyanamide furnaces, in which it was heated, by gas or electricity; up to 800 deg. or 1000 deg. Cent. in an atmosphere of nitrogen, until the absorption of nitrogen, as controlled by the gas-meters, had ceased. The hard cake was then withdrawn, cooled under exclusion of the air, and ground. The gas furnaces used at the original works, at Piano d'Orta, in Italy, were horizontally arranged. The newer furnaces were vertical. The impressive photographs of the Odda works, exhibited by Mr. Cottrell, which had just been opened to turn out 12,500 tons of nitrolim per year (to be raised to 50,000 tons), showed 180 of these vertical cylindrical furnaces arranged in rows, and resting on brickwork pillars; the charging and discharging was done from overhead travellers. All this, we should think, must involve a good deal of labour. The nitrogen was either produced by the Linde process of distilling liquid air, when a nitrogen of 99.8 per cent. was obtained, or by passing air through retort-ovens charged with granulated copper; the nitrogen was equally pure, and the resulting copper oxide was afterwards reduced in the same ovens.

"Most carbide works obtained at present 2 tons of calcium carbide per kilo-

watt-year, and those 2 tons would bind 500 kilogrammes of nitrogen; 2 kilowatts, or 2⅔ horse-power, were hence required per year for fixing 1 ton of nitrogen by the Frank-Caro process, and ⅓ horse-power more had to be allowed for the heating, grinding, and other operations. The price of nitrolim was at present, in Germany, 1.12 marks, against 1.50 marks for Chili saltpetre; and Dr. Frank understood that the same price would be charged in England. We presume that these figures stand for 1 kilogramme of fixed nitrogen. As a fertiliser, nitrolim was about 10 per cent. cheaper than sulphate of ammonia, basing the comparison on the contents of available nitrogen. Nitrolim might be produced with less pure raw material than we needed for the calcium carbide which was to be transformed into acetylene; but equally pure materials are being used, because the yield of carbide would otherwise be impaired. It has long been attempted to carry the carbide and the nitrolim processes out in one operation, but success has not been attained. The views of the Oddo Works exhibited showed that the carbide furnaces adjoined the lime-kilns, 60 feet in height; then came the crushing-houses for the carbide, the crushing-houses for the nitrolim, the nitrolim furnaces, and the storage-bins for the nitrolim, 300 feet long, 50 feet in height. The other works were arranged on similar plans. The North-Western Cyanamide Company was established in 1906; the Sun Gas Company, now known as the Alby United Carbide Factories, and their directors, Mr. Albert Vickers, Sir Vincent Caillard, and Mr. A. E. Barton, took a leading part in it. The first cyanamide works were started two and a half years ago at Piano d'Orta, Italy, in connection with the calcium carbide works of Mr. Morani and the Società Generale per la Cianamide, of Rome. This company was now utilising large water-power also at Terni and at San Michel in the Val d'Aosta. It was water-power also at Odda, in Switzerland, and on the Niagara, in the Dalmatian works (at Sebenico, at Fiume, and at Almissa, 50,000 horse-power projected); at the Notre Dame de Briançon in Haute Savoie, opened six months ago (4000 tons of nitrolim annually); at Bromberg, in Eastern Germany; and on the Alz river, in Bavaria, where the Badische Anilin- und Sodafabrik also make nitric acid by their own electric furnaces. At Brühl, on the Rhine, the power is derived from the local lignite deposits.

"We thus see that many thousand horse-power are at present utilised in this industry, and much larger plants are rising for the same object of fixing the atmospheric nitrogen by the various processes of Birkeland and Eyde, of the Badische Anilin- und Sodafabrik, of Kowalski and Moscicki, Guye, Frank and Caro and others. Most of the fundamental facts underlying the process were understood a hundred years ago; their industrial application forms one of the most remarkable achievements of the last decade."

THE ECONOMICS OF METALLIC FILAMENT LAMPS.

A DISCUSSION OF THEIR ECONOMIC SIGNIFICANCE FROM THE STANDPOINT OF BOTH CONSUMER AND SUPPLIER OF ELECTRICAL ENERGY.

Engineering.

THE probable effect of the general introduction of the high-efficiency metallic-filament incandescent lamp on the electric-lighting industry is a subject to which a great deal of attention is being given in England. We present below a full abstract of an editorial discussion in *Engineering* for May 22, which gives a very clear and concise account of the factors in the problem.

"The introduction of the metallic filament lamp, with its high efficiency and other characteristics, is a matter of no little significance, regarded from the standpoint either of consumers or suppliers of electricity. There are at pres-

ent on the market several types of metallic and other high-efficiency lamps, but two only as yet have obtained a really firm footing. These are the tantalum lamp and the osram lamp, the former having a filament manufactured from the metal tantalum, and the latter provided with a filament of tungsten. The two lamps have many features in common, although presenting individual peculiarities of an important nature. Both have an efficiency of at least from two to three times that of the carbon lamp, with a useful life of about as long. Both are fragile, each in its own manner and degree, but neither having anything like the general robustness of the familiar carbon lamp. The peculiar weakness of the tantalum lamp has so far been the briefness of its life on alternating-current circuits, while the tungsten lamp could only be used with the bulb hanging vertically downwards. The makers of each type, however, now claim to produce lamps in which these defects are overcome, and no doubt further improvements will in due course be effected.

"The tantalum lamp, when new, consumes about 1.7 watts per British candle-power, and has, according to the makers' statement, a useful life of 800 hours, the useful life being taken as the period elapsing before the light is reduced by 20 per cent. The life of a carbon lamp is about the same, and it has a greater prospect of surviving to the normal end of its days; but its consumption is at least 3½ watts per candle, or more than double that of the tantalum lamp. The tungsten lamp is stated to consume 1.25 watts per British candle-power, and to burn about 1000 hours, with a reduction of efficiency of only 5 per cent. It is undoubtedly a frail lamp, but no other type can show an efficiency so high or sustained.

"From independent reports made recently upon osram lamps, supplied by the General Electric Company, Limited, of London, we notice that the watts consumed per mean hemispherical candle-power averaged distinctly less than the figure claimed above, and, in fact, did not attain this figure at the end of 1000 hours, in the case of many of the lamps tested. They were run on a commercial alternating-current circuit, with a voltage variation of 3 per cent. on either side of the mean, and five lamps out of a dozen lasted out the whole test of 2000 hours, none consuming then as much as 1.5 watts per candle. In another test of a dozen lamps, by a diffierent authority, the efficiency was fractionally less. Two lamps failed at 700 hours, one at 2700 hours, and the remaining nine were still running when the test terminated, after 3350 hours. After 2700 hours the average consumption per candle-power was below 2 watts. The voltage during the test was maintained constant at 112 volts. As regards first cost, the present retail price of a tungsten lamp is about 4s., while the tantalum lamp costs 2s. 6d., and a good carbon lamp can be got for 1s.

"Were the new lamps strictly comparable with the ordinary carbon lamp, the latter would be at once driven from the market, in spite of its cheapness, for it could not hope to compete with lamps consuming half or a third the amount of current for the same amount of light. But, in addition to having the drawbacks we have already noted, the metallic lamps are at a serious practical disadvantage. From the nature of things, their filaments are of high conductivity, and must therefore be excessively long and thin to work upon even the lowest of commercial voltages. This not only favours fragility, but renders lamps of low power almost impossible to make. Moreover, the highest terminal pressure that can as yet be used across a single lamp of reasonable power is 130 volts for tungsten and 160 volts for tantalum, so that on most supply circuits in this country it is necessary to run two lamps in series. This involves carefully grading the lamps, for their life is very short under these conditions unless the resistances of both are equal. The General Electric Company have, however, recently put on the market high-power osram lamps designed for burning on pressures up to 260 volts, which cover every lighting circuit in the country.

"The consumer, then, is generally compelled to substitute two metallic

lamps at a point in place of one carbon lamp. This means that he will get probably two or three times the light he previously had, and though it is far cheaper per candle-power, the total bill will be pretty much as before. If he wants the extra light, well and good; but it may be unnecessary, and even embarrassing to him, although he has obtained it for nothing. In places where two separate lights may be controlled by one switch, by means of a slight rearrangement of wiring, two carbon lamps in parallel may be replaced by a pair of metal lamps in series, and the full value of their efficiency obtained. Where the system of supply is alternating, the obvious course is to install a small auto-transformer, and reduce the voltage of the whole house to what is suitable for the particular lamps selected. There will be slight transformer losses, much of which, moreover, will be going on for the whole of the 24 hours, but the current wasted will be very small in comparison with that saved by the new lamps. For tungsten lamps the secondary pressure of the transformer may well be as low as 25 volts, which would allow the use of comparatively robust lamps of very high efficiency, and in units as low as 10 and 16 candle-power.

"Auto-transformers for use with metallic filament lamps are now being made in thousands. They should be so designed that the iron losses, which are going on all the time, should be kept low, and in practice need not exceed 5 watts on a 300-watt transformer, or 10 watts on a transformer of an output of 750 watts. The insignificance of this will be realised when it is remembered that a 16-candle-power carbon lamp consumes something like 60 watts. To avoid the iron losses, such as they are, it is, of course, possible to switch off the transformer when no lamps are needed. In fact, devices have been invented for automatically switching the transformer out with the last lamp, and in again with the first. Such elaborations show a very much exaggerated idea of the losses due to the transformer, which, as a matter of fact, are so small that frequently the current is not sufficient to operate the meter, and therefore never gets charged to the consumer at all.

"We have so far been considering the question of high-efficiency lamps from the consumers' point of view. But it cannot be gainsaid that their general use will seriously affect the business of electricity supply. We may say at once that, arguing from either history, analogy, or common-sense, the ultimate effect of their introduction must be to benefit the industry, although the immediate future may give rise to anxiety. The consumer only uses metallic lamps because he gets some advantage from so doing. Now his satisfaction may arise from one of two causes: either he has got the same light as before for less money, or he has got more light for the same money. Whichever of these conditions occurs, the supply company appears to come off badly, because even in the second case a greater proportion of the annual expenditure on lighting will be diverted into the lampmaker's pocket; while if the total expenditure is less than previously, and the lamps cost more, it is evident that the supply company must suffer even more. Of course, the satisfaction of this consumer with the results of the new lamps may reasonably be expected to cause others to take a supply of current, and thus the output of the station may be maintained. This, however, is not necessarily a benefit to the undertaking. Each unit costs just as much to generate whether it is consumed by one man or shared between a dozen, but in the latter case the price charged for it has to carry the charges on mains, meters, etc., required to give the supply to the eleven others. This may easily swamp any profit earned when the supply was taken by a single consumer.

"The greatest hope of the central-station engineers is that the cheapness of lighting by means of the metal lamps may induce customers to seek advantage rather in the increased quantity of light they may obtain for the same money as before than in the reduction of their current bills. The appetite for artificial light is one that grows by what it feeds on, as is proved by the continuously higher standard of illumination desired,

or even considered essential. The lighting considered adequate a quarter of a century ago would not be tolerated today for a moment, and there is probably plenty of scope for increased illumination in houses and shops which have up to the present been reasonably satisfied with a camparatively few carbon lamps. In fact, the possibility of better light at equal cost is bound to create a demand for it, and the fact that the new lamps are of high individual power, and have frequently to be duplicated, will tend to foster the demand by accustoming customers to brilliant lighting.

"This is the brighter side of the picture, but the alternative has always to be reckoned with. There is no doubt that the lamp makers will very soon find some way of manufacturing lamps of smaller power that will burn singly on high voltages, and in certain districts and among certain classes of consumers the introduction of such lamps is bound to reduce the demand for current per house. Thus small consumers, who are now barely profitable to the undertaking, will be turned into sources of positive loss, because of the capital charges in connecting them to the station. Although we believe such cases will be few and transient, they must be dealt with, or the supply authorities must get into financial difficulties. Practically the only remedy is to raise the price of current or adopt some method of charging which will make every consumer bear his fair share of the costs of supply. Whichever one of these remedies is adopted, the consumer has no just cause of complaint, for he cannot expect to be supplied at a loss to the undertaking, and will certainly be getting better value for his money."

INDUSTRIAL LEGISLATION IN FRANCE.

A DISCUSSION OF THE ECONOMIC EFFECTS OF RECENTLY ENACTED AND PROJECTED STATUTES.

René Duchemin—Le Génie Civil.

WE have referred more than once in these columns to the extent to which the Socialist and Labor representatives in the Chamber of Deputies dictate the policy of the French Government on industrial matters. Their following in the country is much too strong to be disregarded by a Government whose position is never very secure and much ill-considered and pernicious legislation has been the price of their support. We have already outlined the policy of railway nationalization and the effects of the introduction of the eight-hour day in Government works. In the following short abstract of an interesting article by M René Duchemin in *Le Génie Civil* for May 9, are discussed the burdens imposed on French industry by the more recently enacted and projected social laws.

M. Duchemin's discussion is concerned with the workmen's compensation law of 1898, modified in 1902, 1905 and 1906, and the law of 1906 which instituted a weekly day of rest, as statutes already in operation; and with the projected statutes covering compensation for occupational diseases, and workmen's pensions, both of which have reached an advanced stage. He proposes to discover the actual burdens which these laws have placed on the employers of labor, taking as a basis for his calculations an establishment employing 100 workmen per 24 hours, in which the capital invested is a million francs, and in which there are average conditions of danger to workmen.

First, as to the law covering compensation for accidents. The premiums charged by the companies engaged in the accident insurance business vary from 0.6 to 12 per cent. of the pay roll in various classes of works. It is probable that 4 per cent. is rather under than above the average. On this assumption and taking the average wage as 4 fr. 50 per day, the charge for accident insurance for 100 men amounts, on the average, to

not less than 18 francs per day, or 6,300 francs for a year of 350 days. These figures are likely to be increased largely in the near future, because the insurance companies have found that the premiums charged are not sufficient to cover their losses, on account of the abuses which are possible under the administration of the law of 1898. It is a common practice for workmen to make a comparatively insignificant accident the excuse for a long period of idleness. It is easy for them to find doctors, of a class who practically live by such practice, who will give them certificates of incapacity almost as long as desired in return for the opportunity of charging for visits. There is also a tendency on the part of the commissions to be very generous in awarding compensation and it is not an uncommon thing for a workman who has been awarded compensation for permanent disability to remove to a distant part of the country and secure other employment.

The law making a weekly day of rest obligatory recognizes two classes of establishments, those which are permitted to run seven days in the week, and those which have to close down on Sunday. The first class comprise those power using works in which fires have to be kept up continuously. In their case the law has created a new expense in that for one day per week they are obliged to hire a supplementary force of men equal in number to one-seventh of their regular workmen, with additional foremen and superintendents. This expense in itself would not be very great but in nearly every case the regular employees, whose weekly wage the law reduced by one-seventh, demanded and obtained increased pay. In this they were perfectly justified by their necessities but the increase in wages has added greatly to the expenses of the employers. The demand for increased wages could be met in two ways: by raising wages by one-seventh and reducing the number of workmen, and consequently production, in the same proportion; or, keeping production constant, by employing a supplementary force for the day of rest and besides raising the wages of the regular workmen by one-seventh. In the first case, the labor charge remained constant but the fixed charges would increase by an amount which would vary in different industries. In the second case, however, it is apparent that the labor cost would increase one-seventh; that is, in the case we are considering, by 64 francs per day or 22,400 francs per year of 350 days.

In the case of works which are obliged to close down completely one day per week, production could be maintained only by increase in the plant, and consequently in the capital invested. M. Duchemin estimates the annual increase in capital charges, for the case under consideration, at 7,150 francs, which, together with the increase in labor cost, makes a total additional expense of 29,550 francs.

The two laws already in operation, then, mean increases in annual expense of 28,700 francs in the case of works allowed to run seven days in the week, and 35,850 francs in the case of establishments which have to close down entirely one day out of the seven. These amounts represent, respectively, 2.8 and 3.58 per cent. of the invested capital.

As for the proposed legislation mentioned above, the law covering compensation for sickness proposes to establish two classes of indemnity, the first for occupational illnesses of more than thirty days' duration, and the second, for illnesses of any kind whatever lasting less than thirty days. The burden of the first class falls entirely on the employers; in the second, they are responsible only for that part of the illness which may be considered occupational, the workman contributing the rest. The administration of a law of this kind is bound to be unsatisfactory. Notwithstanding the elaborate machinery proposed to overcome the many difficulties that obviously must arise, it is probable that even more serious abuses than now flourish under the law regarding compensation for accidents will be widely practised. Under the circumstances it may be expected that the companies who go into the sickness insurance business will make their rates at least twice as high for this class of insurance as for

accident insurance. This will mean that the employer of 100 men at an average wage of 4 fr. 50 per day will be obliged to pay 12,600 francs in sickness insurance premiums per year of 350 days.

The workmen's pension statute which has reached the Senate places the obligation of providing the funds for this purpose on the employers, the workmen and the State. It is proposed to give every workman in any class of employment, who has reached the age of 60 and has worked for at least 30 years, a life annuity of 360 francs. The employers set aside for this purpose 2 per cent. of the pay roll and the same percentage of his salary is provided by the workman, the State making up the rest. It is apparent that the employer whose case we are considering will have to lay aside 9 francs per day for this purpose, or a total of 3,150 francs per year of 350 days.

The total of the charges imposed on the employer by the two laws already in force and by the proposed legislation if it should finally be enacted amounts, therefore to 44,450 francs for works running continuously, and 51,500 for works shut down on Sundays. These totals represent 4.45 and 5.16 per cent. of the invested capital and they are worth careful study not only as burdens on individuals but also for the consequences they involve. M. Duchemin is in thorough sympathy with the principle of all laws designed to improve the condition of the working classes but, he says, in the elaboration of social laws the utmost precautions must be taken to prevent the impairment of the vitality of the nation, which depends to a large extent on its industries. Before passing additional laws it is necessary that Parliament should make a full and impartial investigation in order to assure itself that the French industries will be able to exist under the burdens which are constantly being added to the heavy load they already carry.

THE CO-OPERATIVE METHOD OF TRAINING ENGINEERS.

A GENERAL OUTLINE OF A PROPOSED SIX-YEAR CO-OPERATIVE COURSE IN ELECTRICAL ENGINEERING.

Magnus W. Alexander—American Institute of Electrical Engineers.

AT the recent Annual Convention of the American Institute of Electrical Engineers an interesting discussion of the co-operative system of engineering education was given by Mr. Magnus W. Alexander. For a number of years Mr. Alexander has been in close touch with the graduate apprenticeship course at the Lynn works of the General Electric Company and he has had abundant opportunity to study at close range the results of a well conceived and well conducted student course of recognized efficiency. He has come to the conclusion that, while the system has been successful in turning out many high-class engineers, the combination of four years mental activity in college with two subsequent years of shop work is not the most effective method of training, since it fails to give that insight into the practical side of electrical engineering and into the proper relation of the economic forces of an industrial organization which is demanded of the leaders in the industrial field. He considers the best solution of the difficult problem of technical education to lie in the co-operative system. We quote at length from his paper:

"A serious study of the situation has led me to believe that the best engineering education can be obtained under a plan which provides that the teaching of the theory and practice should go hand in hand, and, so far as practicable, successive steps in the one should be based on similar advances made in the other, at such intervals as to permit of the most advantageous interplay of the two; and further, that the colleges devote their whole time to the teaching of the theory for which they are so eminently adapted, leaving it to real workshops

to initiate the student into practical work, for which they in turn are best equipped. From an educational standpoint, this plan should prove efficacious, for mental conception of any activity is facilitated by the physical perception of a given process, as illustrated in the whole development of the human being; and on the other hand, mental visions are more firmly clinched by concrete application. Moreover, under such a plan, the freedom enjoyed by students during the college career is happily interrupted by the stern discipline that must prevail in a business organization; the advantage of this college freedom in the development of the young man's character, in the spreading of his wings, so to speak, is not lost, but his freedom is regulated by frequently recurring intervals of discipline in the factory, so that he may be prevented from soaring to the skies in his fanciful ideas engendered by his personal irresponsibility and after four years find himself all too rudely pulled back to earth by the stern call of practical life with its demand for coöperation of all forces. This plan also trains and develops the young man in the very life to which he will devote his future efforts and gives him the love for it, which, after all, is necessary for his success. Economically this coöperative education is sound in principle, in that it will give to the industries engineers who are known to be capable of assuming responsibility and can therefore be placed in positions of leadership. An arrangement of this kind, carrying with it financial remuneration during a part of the time, will attract to engineering work young men who are mentally and physically adapted to it but who at the present time do not enter college for financial reasons or for lack of appreciation of the value of higher education.

"After passing a satisfactory educational and practical test, the young man begins a co-operative course of six years, corresponding to the six years at present occupied by the engineering college education and the factory student course. Under either plan, therefore, the junior engineer will start his life's work after the same length of preparation. The plan which I have in mind provides that the first five years be spent in alternating periods at the college and factory, leaving the sixth year to be devoted entirely to college work. Under this arrangement, co-operative students will be taught in separate classes for the first five years at college, but in their senior year, they may be merged with the regular seniors. The advantage of the latter provision lies in the opportunity which it gives to the engineering apprentice for uninterrupted attention to his thesis and original research work and for forming wider college associations by coming in contact with the larger body of regular college men. This plan has an economic value to the college and places both classes of college students on the same plane with regard to their final examinations and the attainment of their college degrees. The fact that the last year is spent away from the factory will strongly appeal to manufacturers in that those engineering apprentices who upon completion of the coöperative course enter the engineering staff of competing firms will not possess the data relating to the latest developments and experiments. For myself, I rather believe that the last year at college will be interpreted by most students as a leave of absence at the expiration of which they will gladly return to the establishment which made it possible for them to receive an engineering training, and which in turn will willingly offer adequate inducements to secure the services of those with whose special aptitudes it is familiar.

"As to the length of the alternating periods during the first five years of the course, extended experience alone will be able to determine the most efficacious arrangement. We may in the meantime, however, consider various proposals, and, by the process of elimination, narrow our consideration down to the few which in the light of logical reasoning might appeal as efficient. The length of the alternating period is a very important element in this plan, for too long or too short a time may defeat the very objects which the coöperative course seeks to accomplish. In the light of the

aims of the course previously advanced, short periods seem to recommend themselves to us. A year or even six months spent alternatingly at college and at the factory would, I think, fail to give that close coördination of theory and practice that is an essential feature of the plan; nor would it establish that balance between the college freedom and the factory discipline which has already been referred to as very desirable. Short periods, on the other hand, will develop that facility in the young man's physical and mental make-up that will enable him to adjust himself quickly to the interacting influence of the college and the factory. The engineering apprentice should enter upon his factory work as a college boy with all the mental alertness and the inquiring mind fostered by the college; and he should return to the college as an industrial worker with the physical energy and the determined spirit of achievement that will be developed in a hustling factory organization. The attainment of these characteristics will to a large degree determine the success of the plan. Alternating periods of a day or even a week, to take the other extreme, might keep the young man's mind in a rather chaotic state, might not give the seed sown in the class room and factory, respectively, a fair chance to take root. Such time arrangement, moreover, would seriously interfere with the best economy at the factory, and largely forfeit that sympathetic interest of the shop foremen and workmen which seems to me not only desirable but decidedly necessary. Periods of such short duration would prevent also the complete carrying out by the same men of many pieces of work which should form part of their practical education. The finishing of such work by another set of men might often entail loss of time and even spoil the work itself.

"As already stated, any estimate arrived at now in regard to the length of alternating periods must be looked upon as experimental; different factory conditions might lead to different conclusions. Personally, I believe in the efficacy of an arrangement under which the periods increase in duration from the first toward the last year of the course, beginning perhaps with alternations of four or five weeks' duration and ending with time elements of college semesters. In that way, all the advantages of the coöperative course would be emphasized strongly at the beginning when they are of determining influence, and the economic consideration of the college and the factory would receive growing attention in latter years as justified by the increasing importance of the work. An important advantage under a system of alternating periods lies in the fact that one set of students can work in the shop while the other set is engaged at college, and vice versa, thereby keeping the educational and physical equipment employed practically at all times. This plan, of course, presupposes that during the college summer vacations, all engineering apprentices will be utilized at the factory, one-half of them during the first part of the summer with a vacation following during the latter part, and the other half enjoying a rest at the close of the college year and entering upon practical work again during the middle of the summer. . . . .

"The administration of the coöperative course would involve the appointment of a supervisory board with representation from each institution. This board would work out and supervise the details of the course of study both at the college and at the factory, and have general charge of the social and cultural needs of engineering apprentices. It would be an interesting matter to lay out a course of study which would cover the present four years' college course and at the same time lay particular stress on those subjects that may be classed under the general head of applied economics. In view of the elimination from the college course of most of the time now devoted to shop practice, mechanical drawing, and electrical testing, to which subjects the factory will give particular attention, and also on the assumption that the coördinated practical work in the shop will make it possible to cover more ground at college in a given time, it would seem that the present four years' college program could be very nearly

covered in the first five years of the coöperative course. The sixth year, which is entirely spent at college, might, therefore, be devoted to thesis and research work and to special lectures both by the college instructors and by men of affairs in practical life on such subjects as business law and business organization, cost-keeping and factory accounting, the economics of production and methods of equipping and laying out of manufacturing establishments. Seminars for coöperative students in these latter subjects and in many more of a similar character which will take the place of some of the regular fourth year subjects already covered, will prove most interesting and instructive, because practical, and the presentation and discussion of such matters by men of affairs will bring the latter into contact with the student body to the advantage of both. The supervisory board will also from time to time confer and advise with the officers of the college and the industrial establishment as to their respective work, but they shall have no authority or responsibility in regard to the work of either as long as the course is carried out in conformity with the general plan approved by both institutions. . . . . .

"Manufacturers are agreed as to the advantage of interweaving theory and practice in the training of engineers, and many educators are looking in the same direction for an advance in engineering education. It is significant that a technological college of the very first rank has recently expressed willingness to establish a coöperative electrical engineering course along the lines which I have set forth in this paper, and there is good reason to believe that a very prominent concern manufacturing electrical apparatus will soon join in such an undertaking."

COAL DUST AS A FACTOR IN MINE EXPLOSIONS.

A SUMMARY OF PRESENT KNOWLEDGE OF THE PHENOMENA OF DUST EXPLOSIONS.

Dr. Henry H. Payne—Coal Mining Institute.

AT the June meeting of the Coal Mining Institute of America a valuable paper on the subject of mine dust as a factor in coal mine explosions was read by Dr. Henry H. Payne. Dr. Payne is in a position to speak authoritatively on the phenomena of coal mine explosions from his own experience alone, but his paper is made doubly valuable by the fact that it presents a concise review of the more important publications on the subject and a summary of the conclusions reached in the extensive researches on the conditions determining the elements entering into and controlling the inflammability of various dusts, which have been made in England, France and Germany. In conclusion he sums up what his own experience and his wide reading lead him to believe are the established facts and the most credible theories. This part of his paper we reprint in full from *The Industrial World* of June 29.

"Granting that secondary explosions may be propagated indefinitely by the larger sizes, only coal dust which will pass through a No. 100 screen is capable of initial or primary explosion.

"Such dust, after having been subjected to ordinary atmospheric air for only a few hours, becomes largely decomposed and exists as a bubble of constituent gases whose film is composed of undisintegrated carbon and impurities, which, after combustion, are known as ash.

"Such dust, when suspended in a homogeneous cloud with a moderate air velocity, is susceptible of ignition either through shock, compression, or sufficient heat to inaugurate combustion.

"Such results will be classified as combustion or explosion, depending upon the volume of dust ignited, its supply of oxygen and the space within which combustion takes place.

"Where gas alone is ignited, and the mine is free from dust, a 'high explosive' effect is obtained, and the explosion

may be strictly local, due to the cooling effects of the walls.

"The chief product of a dust explosion is carbon monoxide, whose expansion under combustion is greater than that of methane, and which receives its continuous supply of oxygen by feeding toward the intake.

"A dust explosion, while assisted by the intake air, must nevertheless, follow those entries or airways furnishing the most material upon which to feed; and when this course follows the return airways, the conversion of the carbon-monoxide to carbon-dioxide renders the air extinctive, and prohibits further propagation. Evidence of such a condition will be found in the coke splashing or crusts, formed by the deposit of red-hot cinders carried by the air waves, and testifying to incomplete combustion.

"The initial explosion may, and generally does, distil so large an amount of gas that complete combustion is impossible at the site of distillation, and this mass of gas and dust, in varying stages of ignition and combustion at a temperature greatly in excess of the point of ignition, were sufficient oxygen present, will develop into local explosions at irregular intervals wherever adequate atmospheric oxygen is available, such as at junctions of airways, widened passages for side tracks, or cavities where falls of roof rock have occurred, and are frequently called 'flame areas.'

"When such an explosion, either primary or secondary, travels toward a dead-end of an entry passage, the compression generated by its expansion and momentum causes an almost incredible rise in temperature, sufficient to distil the various hydrocarbons from even the ribs of the coal itself, and supplementing it with a heat potential far in excess of its losses through radiation and expansion.

"The liability of any coal dust to explosion increases almost directly with its percentage of volatile matter that is combustible; i. e., the quotient of its percentage of volatile matter divided by the sum of the percentages of volatile matter and fixed carbon.

"While coal dust alone, under the conditions enumerated, is distinctively explosive, the presence of even the smallest amount of methane augments materially the susceptibility to ignition.

"On account of the great elasticity of air, it is highly probable that no proper conception has yet been attained of the almost incredible speed with which a dust explosion, through its gaseous products, may be extended to far distant portions of a mine under the force of initial expansion, properly called the 'percussive theory.'

"Changes in barometric pressure only affects the liability to explosion in so far as they allow, when the barometer is falling, a settling of any possible accumulation of methane from a dome in the roof-rock into the ventilating current; but such small quantities of gas are infinitely safer when diffused in the current of air than when concentrated in one place. Moreover, even if we grant that a low barometer allows greater occlusion, it also allows easier ventilation for the diffusion of such occlusion.

"A mine may be overventilated until the air-current has such a velocity that it stirs up dust and would feed any slight ignition which might take place and otherwise die out.

"The difference in the amount of real dust made by either air-punchers or electric chain-machines is so slight, and so variable, depending on the nature of the coal and the skill of the machine man, that it cannot be said that either machine, as a class, creates more dust, than the other.

"The results of experiments with electric ignition of dust show that the danger from electric wiring is no greater than that of stirring up a cloud of dust from a broken air-pipe or a loose connection.

"Coal dust cannot be made wet, in the usual sense. The method of fine spraying is indicative of the best results; but, even then, it is hypothetical if the most careful system of watering is not merely an infinitesimal portion of the 'ounce of prevention,' and it is an open question whether it is not positively detrimental.

"While the abolition of all explosives, as recommended by the Belgium authori-

ties, appears unnecessary and impracticable in this country, yet the greatest field of investigation now lies along that line, and only those explosives carefully tested and known to be uniformly prepared by well known and responsible manufacturers, should be used. The maintenance of a testing laboratory, even though on a small scale, and the employment of a competent chemical engineer, should be undertaken at every operation of commercial importance."

THE TESTING OF STEEL RAILS.

A CRITICISM OF PREVAILING SPECIFICATIONS AND A DISCUSSION OF THE DROP TEST.

Dr. C. B. Dudley—American Society for Testing Materials.

WE return to the subject of the steel rail situation in the United States, to which considerable attention has been given in both the leading articles and the review department of THE ENGINEERING MAGAZINE during the past year, to present a part of Dr. C. B. Dudley's presidential address before the recent meeting of the American Society for Testing Materials. Dr. Dudley's review of the situation is a most comprehensive one. He first outlines the alteration in conditions during the past twenty-five years and then inquires what the railroads and the rail manufacturers have done to meet the changed conditions. Of the many problems connected with rail manufacture to which he draws attention, he considers one of the most important to be the revision of specifications and methods for rail testing. He is firmly of opinion that the testing of rails can be so handled as to give much more satisfactory results than are at present obtained.

"During the past few years, much light has been thrown on this subject, and the truth compels us to say, that a situation has been found that in some respects would be ludicrous, if it was not so near the tragic. Let us see what the conditions have been:

"(1) The manufacturers have in many cases at least selected the rail end as sample for test. The specifications being silent on the selection of the test piece, they naturally have urged that there was nothing to prevent their doing this, and they naturally again have, so far as information can be obtained, chosen the best steel in the ingot for test. It is not claimed that all specifications have been so loosely drawn as to permit such a suicidal practice, but it is certain that some of them have, and that the practice has been in vogue.

"(2) The best two in three principle has pervaded many specifications, that is to say, if the first rail end stood test, the heat was accepted, but if it failed a second was tested. If this likewise failed the heat was condemned. If, on the other hand, it stood test, a third was tested, and the fate of the heat was decided by the majority. It would almost seem as though the specification had been drawn, not with the idea of being sure that only good rails should be accepted, but with the idea of being sure that as many heats as possible should be accepted.

"(3) Only one heat in five was tested, that is to say, as we understand the matter, if the rail end stood test and the heat was accepted, that acceptance carried four other heats with it. But, singularly enough, if, on the other hand, the heat was rejected, that rejection only covered the heat from which the test rail end came, and the four preceding or following heats, as the case might be, got another chance for their lives. The unsatisfactoriness of such a method of testing, it seems to us, must be evident to every candid mind that knows anything about the making of steel. As has often been stated, every heat of steel is a law unto itself, and there is no certainty that because one heat or blow is good the preceding or succeeding four are equally good any more than there is a reasonable presumption that if one heat is bad, the preceding or succeeding four are likewise bad. And while it is agreed that

when everything is working well successive blows from the Bessemer converter may be similar in many respects, it is not agreed that testing one blow in five gives any reasonable assurance that only good rails are accepted for use.

"We fancy the rather loose testing described in the three items above started in the earlier days when the strain on the rail was far less than at present and the traffic far less dense, and has been perpetuated partly owing to inertia on the part of railroad engineers, and partly owing to the resistance of the rail manufacturers. The wonder is, with such loose, logrolling testing as has been in vogue, not that there have been so many rail failures, but that there have not been more.

"But this is not the whole story. Until quite recently the specifications have been equally loose in regard to the drop testing machine employed in making the tests. Weight of tup has been carefully stated, and the height from which it must fall has been given; indeed, in some cases the foot pounds of the blow are carefully given for each weight of rail, but it has apparently been forgotten that the anvil or support on which the rail rests when it receives the blow is a most important element in the problem. It has recently developed that at one steel works the anvil was a couple of ingots laid down side by side with appliances for holding them in place and supporting the test rail, the whole resting on boards placed on the ground. At another steel works, the anvil weighed 3000 lbs., and rested on boards, stones and gravel. One rail manufacturer recently said in my hearing, 'As long as the railroads did not object, why should we take measures to increase the severity of the test by putting in heavier and better supported anvils?' It is gratifying to be able to state that some of the more recent specifications, while according to our ideas still far from satisfactory in the matter of testing, do show marked improvement in some of the respects mentioned above, and still better, that the rail manufacturers are co-operating in and actually suggesting some of the improvements.

"A few words now in regard to some of the details of testing rails, and first in regard to the drop test. It is well known that many testing engineers do not favor the drop test for rails. To our minds, however, it is the only possible available one for the present, and the following considerations seem to us to have weight in confirming this view:

"(1) It tests the whole rail in the condition in which it goes into the track, instead of a small fraction of the rail, as is requisite in all cases of prepared test pieces.

"(2) It is sufficiently rapid, so that even though every blow is tested there is no fear of delaying the output of the mills, while waiting for test pieces to be prepared, or for slower tests to be made. We have known of a case where, with sufficient force to handle the test samples, 5.5 tests have been made in half an hour on a modern drop testing machine.

"(3) There seems little doubt but that some of the strains or shocks which the rail actually receives in track are similar to those produced by the drop testing machine. This is, we think, clearly the case with a loose joint and a rapidly moving train. In case the track bolts have become loosened, the end of the rail, when the approaching wheel mounts it, certainly gets a blow similar to that given by the drop testing machine. We have known rails which have given long service in track to be broken in this way, and the fracture showed perfectly clean, sound metal.

"(4) Finally, if the specification requires that the deflection be taken, the drop test reveals a good deal in regard to the physical properties of the steel.

"Second, in regard to the selection of the test piece. We fancy it goes, almost without saying, that this should always be made by the inspector. In regard to location of test piece, it is of course understood that in shearing the ingot into rail blooms it is necessary to make the bloom from which the test rail end is to be taken a little longer than the others. It is, therefore, essential that the inspector or the specification should designate the bloom from which the test will be taken. Some recent specifications, wise-

ly, we think, designate the top bloom of the ingot for this purpose, it being generally understood that the so-called 'pipe', if there be any, and the greatest segregation and physical defects, will be in this bloom. We may, perhaps, wisely call attention to the fact that if a cover ably near the bottom end of the top of the ingot when it is cast, the poorest steel in the ingot will not be near the top end of the top bloom, but more probably near the bottom end of the top bloom, so that if the inspector takes his test piece from the top end of the rail made from the top bloom, he will be more apt to deceive himself than if he has the test piece cut from the bottom end of the top bloom. We have sometimes thought, when inspecting the practices of casting and cooling ingots in certain works, that it would be better to take the discard between the first and second blooms.

"Third, in regard to height of drop. We have always opposed extreme severity of tests. Owing to the defects in the anvil previously referred to, if indeed they have been general, it is apparent that but little information that is of value and that is safe to follow can be obtained from previous tests. Our own view is that something a little more severe than the rail will receive in actual service, enough for a reasonable factor of safety, is all sufficient. The trouble is we do not know how severe the shocks in service are. Some recent tests of rails which had broken short off in track made by the research committee of the Pennsylvania System, seem to indicate that a 15 foot drop with a 2000 pound tup and a 20,000 pound anvil would have rejected two-thirds of those which failed in service; also that the 15 foot drop actually broke as many test pieces as the 19 foot drop, other conditions being the same. These tests should be much amplified before final conclusions can be reached, but as far as they go they seem to indicate that we must look to other causes than defective or poor steel for a portion of the rail breakages, and that extremely severe testing is not necessary."

THE GAS PROCESS OF CASE HARDENING.

NOTES ON THE METHODS AND ADVANTAGES OF THE RECENTLY DEVELOPED MACHLET PROCESS.

J. F. Springer--Cassier's Magazine.

THE recent invention of the Machlet gas process is undoubtedly the most important single advance ever made in case-hardening methods. For many purposes case-hardened mild steel is an ideal material, but so little dependence could be placed in the ordinary cementation process to give satisfactory results that the proper extension of case hardening has not taken place. Now, however, with the main difficulties in the process removed case-hardened steel may be expected soon to rank as a popular and dependable material. The following notes on the gas process are taken from an article by Mr. J. F. Springer in *Cassier's Magazine* for July.

"If we consider the matter of quality, we shall find that pack-hardening is hardly to be regarded as absolutely reliable. Thus, on account of differences in chemical constitution of the packing, it is not to be expected that the amounts of carbon delivered at all points is the same or under equal pressure. Taking into account the inevitable inequality in thickness of the surrounding carbonaceous material, it can readily be seen that this method is not to be depended on for uniformity in carbonization. Further, when we reflect that carbonization begins at different points within the case at different times, owing to inequality of temperature, we can easily see that we have here an additional reason operating against uniformity throughout the case.

"At first sight, it may not be evident why uniformity is important. Remem-

bering, however, that the contraction consequent upon the cold plunge at the moment of hardening differs for different degrees of carbonization, we can see that considerable distortion would follow, one part of a piece contracting differently from another part. To allow for this in pieces that are to be ground means expense in grinding.

"A new process, recently invented by Mr. Adolph W. Machlet, strikes at the root of most of the difficulties. This method dispenses with packing altogether, unless, indeed, we regard the work surrounded by gas as packed in gas. In this process there is introduced to the heated work a carbon-laden gas. From this gas the articles absorb carbon. Everywhere there is the same pressure, whether it be a small, threaded hole or some more prominent surface. As the carbon is absorbed by the metal fresh gas as admitted, while the old passes off. No repacking, with its expense for labour and heat and delay, is required, the process being continuous, effective in results, and economical of time and money. The container is continually rotated, which imparts a motion to the work itself. By this means the gas is circulated, which fact tends to improve still further the uniformity of the resulting carbonization.

"A further matter, and one to which attention is here directed, perhaps for the first time, is the fact that this method permits the operation of the process under pressure. This would seem to have possibilities within it. For thus it may be that carbonizations which now require a series of hours may ultimately be found possible of accomplishment in minutes. But in working along on this line it may be well to go slow, for gas under considerable pressures in a red-hot retort, whose walls are softened thus by heat, presents a generation not to be dealt with recklessly.

"The gas used to afford the carbon supply is a special product, produced in a generator specially designed for the purpose. No heat is applied, the process being purely a chemical one. A carbon vapour obtained from an oil is mixed with a neutral gas. It is supposed that the atoms or molecules of carbon are held in suspension in this gas until the moment of absorption by the glowing iron or steel articles to be carbonized.

"The furnace consists essentially of an inner and an outer cylinder. The articles to be case-hardened are placed in the inner cylinder and heat is applied through gas burners to the annular space between the inner and outer cylinders. Worm and worm-wheel gearing are provided to cause the rotation of the cylinder, thus giving all parts of the work equal exposure to the carbonizing gas. The retort itself is supported upon two wheels at each end, thus providing an anti-friction bearing, and also allowing for the expansion due to the heat. . .

"When the retort is to be discharged the lid and the discs connected with it are removed, and by operating a hand-wheel the rear of the furnace and the retort may be raised upon the hinge at the forward end and the contents discharged by gravity.

"Special methods are used for different classes of work, in order to control them properly during the rotation of the retort. Thus, if the pieces are rings, they are strung upon bars secured in the retort in a longitudinal position. Likewise, if the pieces are round bars, which it is desirable shall not mar each other by coming into contact, they may be supported in the perforations of two or more thin discs arranged transversely in the retort, corresponding perforations, of course, being in line. These are made slightly larger than the bars, to permit a rolling movement when the retort is rotated.

"A further difficulty arising under the old method and which is eliminated in the new is the tendency of the gaseous supply of carbon to rise. This would tend to increase the carbonization effected below. By rotating the retort and circulating the gas this is obviated.

"The accessibility of the work is something of marked importance. The work can be seen and its temperature judged directly and simply.

"The hardening operation is effected by a special apparatus designed for the purpose. It consists of the tank which

contains the quenching liquid. A kind of funnel is at one end. Here the hot pieces are received. They then fall into a rotating vessel, also in the shape of a funnel. This is perforated and lies in the liquid, its larger end being next the receiving funnel. The hardening articles pass to this lower and smaller end. Here they are raised and discharged by an apparatus, which is principally a conveyor arranged like a chain in a chain-pump.

"It would seem that the economy of the new process promises a very wide application of case-hardening. Thus, screws, nails, nuts, etc., may be cheaply treated, producing articles whose value would be enhanced by surface hardening. As a method has been developed for straightening shafts while they are being hardened in the cooling bath, it seems possible that we may soon be able to purchase case-hardened and ground shafting by the foot and at commercial prices. This would mean a great deal in machine construction. A further possibility of the process is that of the manufacture of high-carbon steel, the application of the method to this work being largely a matter of cost."

TITANIUM IN CAST IRON.

RESULTS OF TESTS ON THE VALUE AND USE OF FERRO-TITANIUM IN THE FOUNDRY.

Dr. Richard Moldenke—American Foundrymen's Association.

THROUGH the development of the electric furnace, a number of metals, formerly despised on account of the difficulty of their fusion, have been given an economic value and a more or less important place in the metallurgy of iron. One of the latest of these to attain commercial importance is titanium, the ferro-alloy of which is now produced sufficiently cheaply to justify its extensive use. The utility of this alloy in the production of cast iron has recently been made the subject of an extensive series of tests, the results of which were communicated to the June meeting of the American Foundrymen's Association by Dr. Richard Moldenke. We present below a summary of the results and an abstract of Dr. Moldenke's comments.

"Of the two methods of preparing titanium for use in iron, the aluminothermic and the electric furnace, the latter seems destined to make the cheaper product; and as the selling price of a 10 per cent. titanium iron alloy is now within commercial limits, its use for the foundry is worth considering closely. For this purpose a series of tests was instituted on behalf of the American Foundrymen's Association, the results of which are given herewith. In the preliminary tests two classes of alloys were tried, one in which the material was free from carbon, and the other having some 5 per cent. of this element present. The tests showed that while both alloys could be used for the rather small quantities of iron treated, the carbon titanium alloy was better adapted for foundry work, as the melting point is lower. However, the alloy free from carbon can be used in the foundry where large bodies of metal are to be treated, and time can be given for a thorough incorporation of the material.

"The apparent infusibility of the titanium iron alloys has heretofore militated heavily against their use, and hence a word about this matter. When the lumps of alloy are thrown into the ladle, they must be given time enough to heat up and alloy with the bath by thorough stirring. This takes some time, and usually, especially with steel, fear that the metal may cool too much results in pouring before the titanium has done its work. Hence the writer suggests that where large lumps of either alloy are used, they be heated up to redness in any convenient way before use.

"In making the tests in question, the standard 1¼ inch diameter test bar cast on end in a dry sand mold was used. The bars were brushed clean and then tested transversely on supports 12 inches apart.

Two classes of metal were used—broken car wheels and machinery pig iron. This gave gray iron and white iron castings. The alloy contained 10 per cent. titanium, so that 1 pound alloy to 100 pounds iron would mean the addition of 0.1 per cent. titanium. The following is a summary of the results:

	Gray.	White.
Original iron	2,020 lb.	2,050 lb.
Plus 0.05 Ti	3,100 lb.	2,400 lb.
Plus 0.10 Ti	3,030 lb.	
Plus 0.05 Ti. and C	3,070 lb.	2,420 lb.
Plus 0.10 Ti. and C	2,990 lb.	2,400 lb.
Plus 0.15 Ti. and C	3,190 lb.	2,520 lb.
Total tests	23	40
Average strength	3,070 lb.	2,430 lb.

Increase in strength treated iron over original, Gray, 52 per cent.; White, 18 per cent.

"From the above summary it will be seen that the greatest increase in strength was in the gray iron. This is of interest in connection with the recent tests made with vanadium in cast iron where the contrary was observed. The improvement in gray iron is more marked than was the case in tests made by Mr. Rossi and the writer in 1902. The same peculiarities, however, were observed in the behavior of the metal.

"Looking over the averages above presented, it will be noted that the improvement is almost as marked whether 0.05, 0.10 or 0.15 titanium was used, which would seem to indicate that once the deoxidation has been effected, any additional titanium added is partially wasted. Hence, for ordinary foundry practice, 0.05 titanium added will be practically sufficient, larger amounts only being necessary in exceptionally bad cases or for special work.

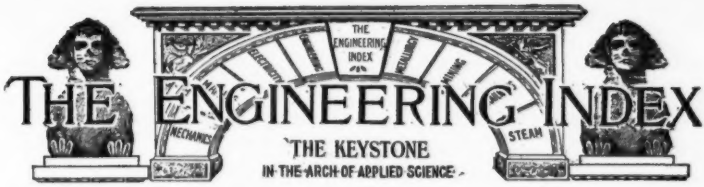
"A further curious fact in connection with the use of titanium in the foundry is the lessening of the chilling action. And yet whatever chill may remain shows very much harder iron. This is important in car wheel work. Test pieces made in the Keystone Car Wheel Works with iron which chilled 1½ inches deep when treated with titanium in the ladle gave but 1 inch chill. Prisms cut from these chilled portions, the castings having been made from the same metal, when subjected to compressive strain and also tested for hardness with Brinell's test (use of diamond) gave the following results: The original iron crushed at 173,000 pounds per square inch and stood 445 in the test for hardness, soft steel running about 105. The treated piece ran 298,000 pounds per square inch and showed a hardness of 557. Testing the soft metal below the chilled portion for hardness gave 332 for the original and 322 for the treated piece, or practically the same material so far as hardness was concerned.

"The writer wishes to call attention to another curious phenomenon in connection with these tests. In order to see what effect the remelting of a titanium pig iron would exhibit, a special batch made in the electric furnace, containing 3.14 titanium and 5.78 graphite, was run through the cupola. The product was cast into test bars the usual way, and part of one ladle into a chill cup. The metal as it came from the electric furnace originally was so tough that it could be broken only with severe exertion. Much of this strength was lost in the cupola remelt, and the composition of the bars was as follows:

Silicon	0.97
Sulphur	0.067
Phosphorus	0.064
Manganese	0.27
Graphite	3.18
Total carbon	3.94
Titanium	0.72

"The bars were dark gray, where one would expect a heavily mottled or at least only very light shade of gray to exist, considering the composition and comparatively small diameter. It was noticed, however, that the bars when cast retained their red heat at least three times as long as ordinarily, and this opportunity for graphite to form may account for the dark gray fracture.

"Just what may be the true explanation for this must be left for future investigation, but perhaps some light may be thrown upon the subject by the following: Experiments made by Mr. Fitzgerald at Niagara Falls in treating molten iron with 1 per cent. titanium, the bath of metal being 2300 degrees F., showed that the addition in question raised the temperature some 25 degrees for a minute; it then slowly dropped to the original again. Evidently there was a reaction involving the giving out of heat. Possibly this may account for the long continued redness of the test bars cast in dry sand molds."



The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	781	Mechanical Engineering	798
Electrical Engineering	789	Mining and Metallurgy	809
Industrial Economy	795	Railway Engineering	817
Marine and Naval Engineering	796	Street and Electric Railways	821

CIVIL ENGINEERING

BRIDGES.

Arches.

Lines of Thrust in Masonry Arches. J. D. W. Ball. Methods of determining stresses are considered. 4000 w. Builder—June 13, 1908. No. 93215 A.

The Calculation of the Stresses in Solid Arches. Milo S. Ketchum. Considers only solid two-hinged and continuous arches constructed of masonry or concrete. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93278 D.

A Simplification of the Design of Hingeless Arches (Vereinfachung der Berechnung gelenkloser Brückengewölbe). Max Ritter. A mathematical paper. Ills. Serial, 1st part. 1000 w. Schweiz Bau—May 30, 1908. No. 93152 D.

Bascule.

Vernon Avenue Bascule Bridge, New York City. Illustrated description of a double-leaf Scherzer rolling lift bridge. 1500 w. Eng Rec—June 27, 1908. No. 93346.

Notes on Electrically Operated Bascule Bridges (Opmerkingen over electrisch bewogen Basculebruggen). F. K. Th. v. Iterson. Illustrates and describes the op-

We supply copies of these articles. See page 823.

erating mechanism. 7800 w. De Ingenieur—May 30, 1908. No. 93188 D.

Columns.

See Latticing, under BRIDGES.

Concrete.

See Trestles, under BRIDGES.

Culverts.

Determination of the Area of Water-Way Required. E. A. Harrison. Considers some of the methods of computing the proper area of culverts. 1500 w. Can Engr—June 5, 1908. No. 92834.

Methods and Cost of Building a Concrete-Steel Culvert to Carry an Irrigation Canal Under a Creek Bed. Henry A. Young. 1500 w. Engng-Con—June 10, 1908. No. 92926.

See also Pipes, under WATER SUPPLY.

Floors.

The Effect of Flooring Plank in Distributing Concentrated Loads. Brief report of thesis work at the Univ. of Nebraska. 1500 w. Eng News—June 4, 1908. No. 92851.

Latticing.

Column Formulas and Lattice Bracing. Discusses the usual methods of calculating stresses, showing how little is really known regarding column strengths and lattice bracing. 2500 w. R R Age Gaz—June 5, 1908. No. 92819.

London.

The Architecture of the Bridges of London. Prof. Beresford Pite. Reviews briefly the architecture of London, and the value of the Thames, and its bridges, illustrating and describing many designs. General discussion. 11500 w. Jour Roy Inst of Brit Archts—May 23, 1908. No. 93006 C.

Reinforced Concrete.

Reinforced Concrete Bridge Over the Sangamon River. Illustrated description of a new bridge on the Wabash line, in Illinois. 600 w. R R Gaz—May 29, 1908. No. 92692.

The Guggersbach Bridge Over the Singine (Pont sur la Singine, à Guggersbach). Am. Gremaud. Illustrated description of a reinforced-concrete arch of 50 metres span. 2000 w. Bul Tech d l Suisse Rom—May 25, 1908. No. 93121 D.

See also Culverts, under BRIDGES.

Steel.

Erection of French River Bridge—Canadian Pacific Railway. C. N. Monsarrat. Illustrated description of interesting features of the work. 3300 w. Can Engr—June 5, 1908. No. 92838.

The Missouri River Bridge of the Chicago and Northwestern Railway at Pierre, South Dakota. Illustrated description of a single-track bridge with swing-span, and the method of erection. 2500 w. Eng Rec—May 30, 1908. No. 92662.

Erection of Heavy Bridges for the New York, New Haven & Hartford Railroad. Describes methods used for handling heavy members of overhead highway spans, without obstructing traffic on the tracks below. 2000 w. Eng Rec—May 30, 1908. No. 92669.

The Design of Bridge End Frames (Zur Berechnung von Brücken-Endquerrahmen). Friedrich Hartmann. Theoretical and mathematical. Ills. 3500 w. Oest Zeit f d Oeffent Baudienst—May 23, 1908. No. 93168 D.

Swing Bridges.

Equipment for Operating Swing Bridge by Power. C. J. Fensome. States the conditions and the methods of determining the power of the motor, the arrrangement, brakes, friction clutch, coupling, etc. 4200 w. Can Engr—June 5, 1908. No. 92836.

Trestles.

How to Build a Concrete Coal Trestle. Warren H. Miller. Illustrated detailed description of a durable trestle which can be built for less money than a wooden one. 2000 w. Power—June 2, 1908. No. 92698.

Viaducts.

Some Detail Points in the Design and Construction of a Railway Viaduct. Philip Aylett. Matters of importance that came to the writer's attention while constructing long bridges and viaducts for the Seaboard Air Line Ry. are discussed in detail. Ills. 3500 w. Eng News—June 18, 1908. No. 93041.

See also Austria, under RAILWAY ENGINEERING, MISCELLANY.

CONSTRUCTION.

Beams.

Bending Moments and Moments of Resistance in a Freely Supported Beam Under Load (Biegungs- und Stützenmomente eines frei aufliegenden Trägers unter einem Lastenzuge). Josef Schreier. A mathematical and theoretical treatment. Ills. Serial, 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 29, 1908. No. 93162 D.

The Graphical Treatment of Continuous Girders on Rigid and Elastic Supports (Zeichnerische Behandlung der durchgehender Träger auf festen, auf elastisch drehbaren, elastisch senkbaren sowie auf elastisch dreh- und senkbaren Stützen). Chr. Vlachos. Discusses various cases. Ills. Plates. 9000 w. Oest Zeitschr f d Oeffent Baudienst—May 16, 1908. No. 93167 D.

Bins.

Reinforced-Concrete Cement Bins (Zementsilo in Eisenbeton). Emil Reich. A discussion of the design of a five-compartment building for cement storage, about 120 feet long by 33 feet wide. Ills.

We supply copies of these articles. See page 823.

3300 w. Beton u Eisen—May 14, 1908. No. 93153 F.

Caissons.

See Piers, under WATERWAYS AND HARBORS; and Dry Docks, under MARINE AND NAVAL ENGINEERING.

Columns.

Notes on Euler's Theory of Rupture (Bemerkungen zur Eulerschen Knicktheorie). H. Lorenz. A mathematical discussion. Ills. 3300 w. Zeitschr d Ver Deutcher Ing—May 23 ,1908. No. 93183 D.

Concrete.

A Concrete Church with Ornamental Cast Concrete Details. Illustrated description of the church of "Our Lady of Loretto," in Brooklyn, N. Y. 1000 w. Eng News—June 25, 1908. No. 93338.

The Construction and Cost of a Concrete Gasholder Tank. Ernest Frith. Gives details of a tank at the works of the Runcorn Gas Co. Also discussion. Ills. 3800 w. Gas Wld—June 13, 1908. No. 93212 A.

See also Fireproof, under CONSTRUCTION.

Concrete Blocks.

Some of the Methods of Cuban Block Makers and Cement Workers. George Rice. Describes the method of using wooden molds, tamping devices, etc. Ills. 800 w. Engng-Con—June 17, 1908. No. 93089.

Earth Pressures.

The Pressure of Earth Filling on Bracing in Trenches. Milo S. Ketchum. Gives a solution of the problem of earth pressures on the sheeting of deep trenches. 1000 w. Jour of Engng, Univ of Colo—No. 4. No. 93285 D.

Ellis Island, N. Y.

Recent Improvements at the United States Immigrant Station, Ellis Island, N. Y. An illustrated account of the construction of an entirely new island, and of a group of 17 buildings, forming a hospital for the treatment of contagious diseases. 2000 w. Eng Rec—May 30, 1908. No. 92667.

Excavation.

Rock Excavation by Mechanical Power Instead of Explosions. Editorial discussion of the Lobnitz system. 2200 w. Eng News—June 25, 1908. No. 93340.

See also Sewers, under MUNICIPAL.

Failures.

An Apartment-House Building Failure, Washington, D. C. Illustrated description of the collapse of this steel-brick structure and discussion of the cause. 1000 w. Eng News—June 25, 1908. No. 93339.

An Unusual Building Accident: Foundation Failure During Construction. An account of an accident to a hospital building in Pittsburg. Ills. 800 w. Eng News—June 11, 1908. No. 92941.

Investigation of Collapse of Filter Roof During Construction at Lawrence, Mass. Sanford E. Thompson. Brief illustrated description of the method of construction, and of the condition after the fall, giving data collected and conclusions in regard to the causes of the failure. 3000 w. Jour N Eng W-Wks Assn —June, 1908. No. 93378 F.

Fireproof.

The Fireproof Properties of Concrete. Concise contributions from leading engineers and experts on the value of concrete as a fireproof material. Ills. 13500 w. Cement Age—June, 1908. No. 93009.

Fireproof Building Construction and Concrete Building Construction. Abstracts of two reports presented at the recent convention of the Nat. Fire Protection Assn. in Chicago. 2800 w. Eng News—June 11, 1908. No. 92936.

Foundations.

Concrete Pile Foundations to a Heavy Reinforced-Concrete Warehouse. Charles R. Coats. Describes work on uncertain ground at Louisville, Ky. 900 w. Eng News—June 4, 1908. No. 92853.

See also Failures, under CONSTRUCTION.

Masonry.

Masonry Work in Zero Weather. T. B. Kidner. A brief account of the methods of safely carrying on work in such weather. Ills. 1500 w. Builder—June 13, 1908. No. 93216 A.

See also Retaining Walls, under CONSTRUCTION; and Dams, under WATER SUPPLY.

Piling.

Concrete Piles. Stewart G. Collins. Discusses their advantages, giving illustrated description of the Raymond and the Simplex methods. 1400 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93387 N.

Reinforced Concrete as a Substitute for Wooden Piles and Cross-Ties or Sleepers. Alexander Crawford Chenoweth. Discusses this subject, presenting a method of construction, using no forms, producing a pile by simply rolling a sheet of concrete and metal netting into a solid cylinder. General discussion. Ills. 10500 w. Pro N Y R R Club—May 15, 1908. No. 93017.

See also Foundations, under CONSTRUCTION; and Cofferdams, under WATERWAYS AND HARBORS.

Reinforced Concrete.

Reinforced Concrete in Municipal Engineering. W. Noble Twelvetrees. States some of the advantages of this material. 2000 w. Surveyor—June 12, 1908. No. 93213 A.

We supply copies of these articles. See page 823.

A Reinforced-Concrete Cold-Storage Building. William F. Tubesing. Illustrated description of the Roth Packing Co.'s cold-storage house at Cincinnati. 1500 w. Eng News—June 11, 1908. No. 92935.

Concrete Buildings for the Great Atlantic and Pacific Tea Company, Jersey City, N. J. J. P. H. Perry. Illustrated description of a plant consisting of a warehouse and general office building and a power house, discussing the method of construction. 2000 w. Archts & Bldrs Mag—June, 1908. No. 93088 C.

The Application of Reinforced Concrete to the Construction of the Lafitte Publishing Company's Building, Paris (Application du Béton armé à la Construction de l'Hôtel des Publications Lafitte, à Paris). Illustrates and describes this 7-story structure. 2500 w. Génie Civil—May 30, 1908. No. 93131 D.

See also Bins, Piling, Retaining Walls, and Stacks, under CONSTRUCTION; Sewage Disposal, under MUNICIPAL; Pipes, under WATER SUPPLY; Shaft Sinking, under MINING AND METALLURGY, MINING; and Coaling Plants, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

The Design of Retaining Walls. Harold A. Petterson. Discusses the most economical forms of wall for sustaining earth pressures, giving tables and diagrams which will facilitate their design. Masonry walls of gravity section and reinforced concrete walls will be considered. 1500 w. Eng Rec—June 13, 1908. Serial, 1st part. No. 92955.

Stacks.

A Tall Concrete Smelter Chimney. Describes a 350-ft. concrete chimney, with 18 ft. inside diameter, built at Butte, Mont. Ills. 2000 w. Eng Rec—June 6, 1908. No. 92832.

Steel Buildings.

Some Recent Steel Cage Buildings in San Francisco. Illustrates and describes structures, explaining the requirements of the building laws. 2500 w. Eng Rec—June 13, 1908. No. 92953.

The City Investing Building. Francis H. Kimball. Illustrates and describes interesting features of this 32-story building in New York City. 3000 w. Archts & Bldrs Mag—June, 1908. No. 93087 C.

Tunnels.

Itemized Cost of the Stampede Tunnel (9,850 Lin. Ft.) and Its Masonry Lining. Information in regard to a tunnel on the Northern Pacific Ry. 1500 w. Engng-Con—June 3, 1908. No. 92784.

Tunnel Breakage, Outside of Prescribed Cross-Section; Clinch Valley Division, Norfolk & Western R. R. Emile Low. Information in regard to the geological formation, and the causes of excessive breakage. Ills. 900 w. Eng News—June 18, 1908. No. 93045.

The Intake Tunnel of the Municipal Water-Works at Gary, Indiana. Illustrated description of the construction of 15,000 ft. of tunnel of horse-shoe shape, with cross-section equivalent to a 6 ft. circle. 2500 w. Eng Rec—June 27, 1908. No. 93343.

Underpinning.

Underpinning Six-Story Apartment Houses in New York City. Work in connection with the construction of the bridge-loop subway is illustrated and described. 1200 w. Eng Rec—May 30, 1908. No. 92663.

MATERIALS OF CONSTRUCTION.

Brick.

See Blast-Furnace Slag, under MINING AND METALLURGY, IRON AND STEEL.

Cement.

Iron-Ore Cement in Germany. Information from a Consular Report concerning the production and use of this cement. 1400 w. Eng News—June 25, 1908. No. 93342.

Destruction of Cement Mortar and Concrete by Alkali Salts at Great Falls, Mont., with Discussion of the Effect of Alkali on Portland Cement. On damage to sewers, and a report of investigations recently made. 2000 w. Engng-Con—June 24, 1908. No. 93329.

Tests of Some Pozzolane (Studio di alcune Pozzolane). Ernesto Isè. Compares their physical properties. Ills. 2800 w. Il Cemento—April, 1908. No. 93134 D.

A Microscopic Study of Pozzolana Cement (Studio microscopico delle Malte a Pozzolana). Gino Gallo. Illustrated by microphotographs. 11000 w. Ann d Soc d Ing e d Arch Ital—Mar.-Apr., 1908. No. 93132 F.

A Method for the More Thorough Investigation of Hydraulic Cement (Ein Studienplan für die weitere Erforschung der hydraulischen Bindemittel). Karl Zulkowski. Criticises present methods and suggests improvements. Serial, 1st part. 2000 w. Stahl u Eisen—May 13, 1908. No. 93144 D.

Concrete.

Permeability Tests of Concrete with the Addition of Hydrated Lime. Sanford E. Thompson. Read before the Am. Soc. for Test. Mat. Gives conclusions drawn from experiments, with a study of results. 3500 w. Eng Rec—June 27, 1908. No. 93347.

Comparative Tests of Sandstone and Slag as Concrete Aggregates. Frederick

We supply copies of these articles. See page 823.

W. Doolittle. Reports a series of tests made to determine the relative merits. 800 w. Jour of Engng, Univ of Colo—No. 4. No. 93290 D.

See also Cement, under MATERIALS OF CONSTRUCTION.

Paints.

Methods for Protecting Iron and Steel Against Corrosion. George B. Heckel. Reviews work on protective coatings, giving report of tests. Ills. 5500 w. Jour Fr Inst—June, 1908. No. 93260 D.

Reinforced Concrete.

Tests of Bond in Reinforced Concrete Beams. Morton O. Whitey. Read before the Am. Soc. for Test. Mat. Reports tests made. 2500 w. Eng Rec—June 27, 1908. No. 93344.

Comparative Rupture Tests on Reinforced Concrete Test Pieces Made of Königshof Slag Cement (Vergleichende Bruchversuche mit Probeobjekten aus Eisenbeton unter Verwendung des Königshofer Schlackenzements). M. Blodnig. Describes the tests and gives the results and conclusions. Ills. 3500 w. Beton u Eisen—May 14, 1908. No. 93154 F.

Steel.

New Uses for Steel. R. B. Woodworth. Deals with its application to substructure work, especially the cofferdam. Ills. Discussion. 8700 w. Pro Ry Club of Pittsburgh—April, 1908. No. 93365 C.

The Work of the Testing Department of the Watertown Arsenal, in Its Relation to the Metallurgy of Steel. A discussion of the paper of James E. Howard. Ills. 9000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93269 D.

Timber Reservation.

The Treatment of Timber. Carl G. Crawford. Abstract from a Circ. of the U. S. Dept. of Agri. An illustrated account of the open-tank method. 3000 w. Sci Am Sup—June 6, 1908. No. 92801.

Timber Preservation. Ralph H. Rawson. Illustrated description of the creosoting process and of the plant of the Pacific Creosoting Co. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93389 N.

MEASUREMENT.

Earthwork.

An Excess Curve of Quantities for Trapezoidal Canal Sections. Harry E. Sovereign. Describes a curve designed in a field office of the U. S. Reclamation Service, found to be very useful. 800 w. Jour of Engng, Univ of Colo—No. 4. No. 93280 D.

Testing Laboratories.

A Laboratory for Testing Materials of Construction (Il Laboratorio sperimentale per i Materiali da Costruzione). Illustrated description of the Laboratory of the Technical Institute at Milan. 3000 w. Serial. 1st part. Il Cemento—April, 1908. No. 93135 D.

MUNICIPAL.

Blackpool.

Blackpool and Some of Its Municipal Works. John S. Brodie. Read before the Assn. of Munic. & Co. Engrs. Briefly describes the various works and undertakings. Ills. 7500 w. Surveyor—June 19, 1908. Serial, 1st part. No. 93411 A.

Garbage Disposal.

The Collection and Disposal of Municipal Waste and Refuse. X. H. Goodnough. Information concerning the quantity and character of city wastes, and the methods of disposal. 9000 w. Jour Assn of Engng Socs—May, 1908. No. 93369 D.

Gary, Ind.

Municipal Engineering at Gary, Ind. Will Lawrence Hammons. Describes the paved streets and concrete sidewalks, the water system, sewers, etc. 2000 w. Munic Engng—June, 1908. No. 93055 C.

Pavements.

The Evolution of Pavements. G. L. Clausen. A short résumé of the writer's observations during twenty-eight years' experience in municipal work. 1200 w. Munic Engng—June, 1908. No. 93057 C.

Hints on Fillers for Brick and Block Pavements. C. G. Atwater. Considers coal tar pitch the most satisfactory and the cheapest. 800 w. Engng-Con—June 10, 1908. No. 92927.

The Municipal Asphalt Repair Plant of the Borough of Brooklyn, and Data on the Cost of Operating It. Gives data covering the period from June 13 to Dec. 31, 1907. 2000 w. Engng-Con—May 27, 1908. No. 92687.

Roads.

State Road Building in Pennsylvania. Leonard C. Jordan. Describes the method of construction. 1600 w. Jour of Engng, Univ of Colo—No. 4. No. 93283 D.

Data on Tarvia Road Treatment in New York State, and Tar Macadam Work in Canada. Information from H. C. Poore's report to the Massachusetts Highway Commission. 3800 w. Engng-Con—June 3, 1908. No. 92782.

Roadways That Will Resist the Wheels of Automobiles. Editorial comment on the roads of Central Park, N. Y. City, and the effect of motor vehicles on the macadam and the remedy. 1200 w. Engng-Con—June 10, 1908. No. 92925.

The Effect of Motors on Roads. Douglas Mackenzie. An illustrated article discussing the nature of the injuries. Also Notes on Wheel Diameters. Col. R. E. Crompton. Discussed together. 9000 w. Surveyor—June 5, 1908. No. 92920 A.

We supply copies of these articles. See page 823.

Sanitation.

The Management of the Typhoid Fever Epidemic at Watertown, N. Y., in 1904. George A. Soper. Deals with features in the sanitary management of an epidemic caused by a polluted water supply. Ills. Discussion. 2500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93374 F.

Sewage Disposal.

Chemical Precipitation v. Septic Tanks. Joshua Bolton. Gives results of tests made at Heywood. 2500 w. Surveyor—June 12, 1908. No. 93214 A.

Sewage Disposal for Private Houses. J. B. Neely. Illustrates and describes the main features of plants built from plans of A. Marston. 800 w. Eng Rec—May 30, 1908. No. 92666.

New Sewage Works at Twickenham. An illustrated description of a plant considered quite a model. 2500 w. Engr, Lond—June 5, 1908. Serial. 1st part. No. 92990 A.

Sewage Disposal at Boulder, Colorado. Clement C. Williams. Describes the method of sewage treatment, which is criticized, and suggests improvements. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93287 D.

Special Features of the Sewage Pumping Machinery, Reinforced Concrete Rising Main, and Travis System Sewage Tanks in Progress at Norwich, England. Arthur E. Collins. Illustrated detailed description. 6500 w. Surveyor—June 5, 1908. Serial. 1st part. No. 92919 A.

Sewage Purification Works of the State Agricultural School, St. Anthony Park, Minn. Frederick H. Bass. Illustrated description of a system for domestic sewage only, consisting of a septic tank, percolating filter, settling tank and a sand filter. 1000 w. Eng News—June 25, 1908. No. 93335.

Sewerage Statistics. Collected and tabulated by the Sanitary Section of the Boston Society of Civil Engineers. 1700 w. Jour Assn of Engng Socs—May, 1908. No. 93370 D.

Sewers.

The Design of a Sewer. Frank R. Durham. Discusses systems of sewerage, the general principles if sewer design, giving diagrams and drawings of the writer's work. 6800 w. Surveyor—May 22, 1908. Serial. 1st part. No. 92736 A.

Excavators and Steam Shovels in Sewer Construction. Frank C. Perkins. A report of work done by labor saving devices. Ills. 1200 w. Munic Engng—June, 1908. No. 93056 C.

Outfall Sewer Extensions in Oakland, California. Explains conditions and describes changes made. 1200 w. Eng Rec—May 30, 1908. No. 92670.

The Winston-Salem Intercepting Sewer. J. N. Ambler. An account of the rebuilding of a sewer in North Carolina. Ills. 4000 w. Eng News—June 25, 1908. No. 93341.

Method and Cost of Building a Pipe Sewer Through Quicksand, Excavating the Ground with a Pump, Showing Remarkable Economy. Report of work at Wild Wood, New Jersey. 1200 w. Engng-Con—June 3, 1908. No. 92783.

See also Sewage Disposal, under MUNICIPAL.

WATER SUPPLY.

Aqueducts.

See Culverts, under BRIDGES.

Ashokan.

Some Geological Features Affecting the Catskill Water Supply. J. F. Sanborn. A brief outline of the most prominent geological features affecting the work under construction to give additional supply for New York City. Ills. 1200 w. Harvard Engng Jour—June, 1908. No. 93023 D.

Progress on the Ashokan Reservoir. An illustrated account of the great work in progress to secure additional water supply for New York City, and preparations made to meet the requirements. 6000 w. Eng Rec—June 13, 1908. No. 92952.

Conduits.

See Tunnels, under CONSTRUCTION.

Dams.

The Stresses in Masonry Dams. Illustrations and remarks on the experiments of Messrs. Wilson and Gore on model dams, as reported to the Inst. of Civ. Engrs. 1600 w. Engng—May 22, 1908. No. 92752 A.

The Government's Great Storage Dams. Henri V. Leménager. Discusses what they will accomplish toward the conservation and development of the natural resources of the west. Ills. 2500 w. Am Rev of Revs—June, 1908. No. 92912 C.

The Cataract Dam of the Water-Supply System of Sydney, New South Wales. Illustrated description of this large concrete and stone masonry dam, which has notable features of design and construction. 3000 w. Eng Rec—June 6, 1908. No. 92826.

Filtration.

Filter Operations, Investigations for Additional Supply and Construction of new Filter at Lawrence, Mass. Morris Knowles, M. F. Collins and Arthur D. Marble. Gives the history of the old filter, changes in methods of operation and equipment; the agitation for a new supply, with description of the filter and some items of cost. Ills. 10000 w. Jour N Eng W-Wks Assn—June, 1908. No. 93377 F.

We supply copies of these articles. See page 823.

Fire Protection.

City of Winnipeg, High Pressure Fire Service. Illustrated description of a system having a water pressure of 300 lbs. per sq. in. and a maximum capacity of 9000 imperial gallons per minute. 1500 w. Can Engr—June 5, 1908. No. 92839.

Ground Waters.

Geologic Basis for Artesian Prediction. N. H. Darton. Abstract of paper read before the Am. W.-Wks. Assn. Explains some of the fundamental principles which guide geologists. Ills. 1700 w. Eng Rec—May 30, 1908. No. 92661.

Hygiene.

Conservation of Life and Health by Improved Water Supply. Abstract of an address by George M. Kober, presented at the Conference on Conservation of Natural Resources. Discusses the influence of public water supply on the death rate. 6000 w. Eng Rec—June 6, 1908. No. 92831.

Irrigation.

The Alberta Irrigation Project of the Canadian Pacific Railway Co. J. S. Dennis. An illustrated account of the surveys and general engineering features. 3000 w. Eng Rec—June 13, 1908. No. 92947.

The Salt River Project. A. P. Davis. An illustrated account of conditions and difficulties met in developing the irrigation project in Arizona. 1200 w. Eng Rec—June 20, 1908. No. 93061.

See also Dams, and Reservoirs, under WATER SUPPLY.

Kalgoorlie.

Water Supply for Kalgoorlie. M. W. von Bernewitz. A brief account of the Mundaring reservoir supply. Ills. 900 w. Min & Sci Pr—May 23, 1908. No. 92683.

Pipe Flow.

Investigation of Flow Through Large Submerged Orifices and Tubes. Clinton Brown Stewart. The present paper gives experiments with submerged tubes four feet square, studying the effect of changing the length of the tube and of modifying the entrance conditions. Ills. 11500 w. Bul Univ of Wis, No. 216—April, 1908. No. 93367 C.

Pipe Incrustation.

Incrustation of Water Pipe. W. R. Gelston. Read before the Am. W.-Wks. Assn. The writer's experience at Quincy, Ill., emphasizing the fact that solutions of iron and lime should not be forced together through long lines of pipe. 1800 w. Munic Engng—June, 1908. No. 93059 C.

Pipe Line Repairs.

Repairs to a 72-inch Steel Main Under 30 Feet of Water. A. W. Cuddeback. Abstract of a paper before the Am. W.-Wks. Assn. Describes repairs on a line under the Hackensack River, N. J. 2200 w. Eng Rec—May 30, 1908. No. 92668.

Pipes.

Tests of Cast-Iron and Reinforced-Concrete Culvert Pipe. Arthur N. Talbot. A report of tests made, comparing and discussing the results. Ills. 15700 w. Univ of Ills, Bul 22—April 29, 1908. No. 93011 N.

Protection.

Sanitary Patrol of Watersheds. Theodore Horton, in the *Monthly Bul. of the N. Y. State Dept. of Health.* On the importance of systematic inspection. 3000 w. Eng Rec—June 20, 1908. No. 93062.

Purification.

Experiments on the Preliminary Treatment of Potomac River Water at Washington, D. C. Francis F. Longley. Describes and discusses the experiments made. Ills. Also editorial. 8300 w. Eng Rec—June 27, 1908. No. 93350.

Sterile Drinking Water for Large Buildings. T. N. Thompson. Begins a discussion of the methods for purifying drinking water. Considers the limits of ordinary filters. 1200 w. Met Work—June 6, 1908. Serial. 1st part. No. 92766.

Reservoirs.

Preliminary Reports on Storage Reservoirs. Lyman E. Bishop. Discusses the problem of locating a flood water reservoir for irrigation. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93288 D.

Stripping Reservoir Lands. J. M. Diven. Gives experience with stripped and unstripped land, describing conditions. 2500 w. Munic Engng—June, 1908. No. 93058 C.

See also Ashokan, under WATER SUPPLY.

Siphons.

The Operation of a 16-Inch Water-Main Siphon. From a paper by Howard A. Dill, before the Am. W.-Wks. Assn., describing the operation of a siphon at Richmond, Ind. 1600 w. Eng Rec—June 13, 1908. No. 92951.

Standpipes.

The Failure of a Wrought-Iron Standpipe at Waterloo, N. Y., from Pitting. H. J. Morrison. An illustrated account of the failure, describing the condition of the material. 1500 w. Eng News—June 25, 1908. No. 93333.

Stream Flow.

Comparison of Formulas for Computation of Stream Discharge. J. C. Stevens. Read before the conference of district engineers U. S. Geol. Survey. Gives a statement of conclusions reached and a report of the comparison made. 3000 w. Eng News—June 25, 1908. No. 93334.

We supply copies of these articles. See page 823.

Water Works.

The Troy (N. Y.) Water Works Extension. E. L. Grimes. Reviews the history of the water supply, and describes in detail the new system, giving cost and information of interest. Ills. 5500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93375 F.

WATERWAYS AND HARBORS.

Breakwaters.

See Havre, under WATERWAYS AND HARBORS.

Canals.

The Extension of the Emperor William Canal. Editorial discussion of the extensions and alterations proposed in this North Sea-Baltic canal. 3000 w. Engng—May 29, 1908. No. 92875 A.

The Cape Cod Canal Project. William Barclay Parsons. A general discussion of this important work, the traffic that would use it, and matters related. 4000 w. R R Gaz—May 29, 1908. No. 92690.

See also Panama Canal, under WATERWAYS AND HARBORS.

Cofferdams.

An Extensive Cofferdam of Steel Sheet Piling. Illustrated description of work at Buffalo, N. Y. 1200 w. Eng Rec—June 13, 1908. No. 92950.

See also Steel, under MATERIALS OF CONSTRUCTION.

Dredging.

The Disposal of Dredgings in Closed Conduits (Refoulement des Produits de Dragages en Conduits fermées). MM. Vidal and Kauffmann. An elaborate account of reclamation work on the marshes surrounding Bordeaux carried out in connection with dredging operations on the River Garonne. Ills. Plates. 35000 w. Ann des Ponts et Chaussées—1907-VI. No. 93119 E + F.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

East Coast Waterways.

The Pamlico Sound Section of the East Coast Inland Waterway. G. S. Scherer. Map and description of the proposed work. 1000 w. Eng News—June 4, 1908. No. 92848.

Floods.

See River Regulation, under WATERWAYS AND HARBORS.

Harbors.

See Havre, under WATERWAYS AND HARBORS.

Havre.

Havre Port Works. Detailed description of the construction of the new breakwaters, the deep water quay and the Florida lock. Ills. 2500 w. Engr, Lond—May 29, 1908. Serial. 1st part. No. 92879 A.

Locks.

The Lock in the Charles River Dam, Boston. Walton H. Sears. An illustrated description of the lock and its appurtenances. 3500 w. Eng Rec—June 13, 1908. No. 92948.

See also Havre, under WATERWAYS AND HARBORS.

New Jersey.

Waterways of New Jersey. Abstract of an address by Hon. John Franklin Fort, before the Conference on the Conservation of Natural Resources at Washington. On the utilization of natural and artificial waterways, especially in the State of New Jersey. 5000 w. Eng Rec—June 20, 1908. No. 93065.

Ohio River.

See River Regulation, under WATERWAYS AND HARBORS.

Panama Canal.

Panama Canal: Final Plan and Present Condition of the Work. Diagrams. 1500 w. Sci Am—June 6, 1908. No. 92799.

Tangible Progress on the Panama Canal. Oliver G. Tubby. Aims to give an idea of the present condition of the work. Ills. 3000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93382 N.

Piers.

The California City Point Coal Pier. Illustrated description of a U. S. coal depot on the Pacific Coast. 2000 w. Eng Rec—June 27, 1908. No. 93345.

The Employment of Reinforced-Concrete Pneumatic Caissons for the Foundation of Quay Walls (L'Emploi de Caissons en Beton armé pour la Fondation de Murs de Quais à l'Aide de Procédés pneumatiques). M. Herzog. Description of work in Dieppe harbor with notes on the design of the caissons. Ills. 7000 w. Ann des Ponts et Chaussées—1907-VI. No. 93120 E + F.

See also Havre, under WATERWAYS AND HARBORS.

River Regulation.

The Application of the Reservoir System to the Improvement of the Ohio River. Capt. Wm. D. Connor. A critical discussion of a recent article by M. O. Leighton on this subect, with reply by Mr. Leighton, and editorial. 12000 w. Eng News—June 11, 1908. No. 92934.

The Effect of the Conservation of Flow in the Ohio Basin on Floods in the Lower Mississippi. A. H. Horton. Claims that the Ohio practically controls the lower Mississippi. 3000 w. Eng News—June 11, 1908. No. 92938.

River Regulation (Ueber Flussregulierungen). Ignatz Pollak. A review of experiences in Austria in connection with the improvement of inland navigation. Serial.

We supply copies of these articles. See page 823.

1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—May 1, 1908. No. 93160 D.

U. S. Waterways.

The Navigation Resources of American Waterways. Abridged statement from the paper of Prof. Emory R. Johnson before the Washington conference. 2700 w. Eng Rec—June 27, 1908. No. 93349.

The Mississippi River Problem. Walter Sheldon Tower. Discusses the importance of a deep waterway from the Great Lakes to the Gulf of Mexico, and the serious problems that must be solved; the suggestions for river control, and related subjects. 7700 w. Pop Sci M—July, 1908. No. 93368 D.

Water Powers.

Power Capacity of a Running Stream Without Storage. William G. Raymond. Aims to show that for streams upon which there is no storage, the only proper way to estimate the power available is to estimate it from the daily rather than the monthly flow. 2500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93376 F.

MISCELLANY.

Natural Resources.

The Waste of Our Fuel Resources. I. C. White. Abstract of an address at the conference in Washington, D. C. Discusses the waste of natural gas, oil, and coal. 4500 w. Power—June 2, 1908. No. 92700.

The Natural Wealth of the Land and Its Conservation. James J. Hill. From an address at the conference at Washington, D. C. The importance of agriculture, the yield of the land, its deterioration and the remedy. 4000 w. Ir Age—June 4, 1908. No. 92724.

ELECTRICAL ENGINEERING

COMMUNICATION.

Army Signalling.

New Electrical Apparatus of the United States Signal Corps. C. H. Claudy. Illustrated description of special apparatus used, a portable telephone, wireless telegraphy, telautograph for transmitting gun ranges, etc. 2000 w. Sci Am—June 20, 1908. No. 93049.

Radio-Telegraphy.

Knudsen's Process of Transmitting Pictures by Wireless Telegraphy. Brief illustrated description. 1200 w. Sci Am—June 6, 1908. No. 92800.

See also Army Signalling, under COMMUNICATION.

Radio-Telephony.

The Poulsen Wireless Telephone. Otto Nairz. Illustrated detailed description of the system of the German Wireless Telegraph Co. 1500 w. Sci Am Sup—June 6, 1908. No. 92802.

Wireless Telephony. R. A. Fessenden. A discussion of the theory, practical operation, and possibilities, with brief review of the history of wireless signaling. Ills. 1600 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93297 D.

Telegraph Cables.

An Oscillographic Study of Induction in Telegraph Cables (Oszillographische Untersuchungen zur Frage der Induktion in Telegraphenkabeln). E. F. Petritsch. A description of the researches and conclusions reached. Ills. Serial. 1st part. 3200 w. Elektrotech u Maschinenbau—May 10, 1908. No. 93171 D.

Tele-Mechanic.

Wireless. Information concerning Dr. F. H. Millener's apparatus for remote control of machinery. Ills. 900 w. Ry & Loc Engng—June, 1908. No. 92789 C.

Telephone Lines.

Method and Cost of Constructing a Telephone Line. L. E. Hurtz. (Condensed.) 3500 w. Engng-Con—May 27, 1908. No. 92688.

Telephony.

The Theory and Practice of Phantom Telephone Circuits. F. J. Mayer. Explains the term and the operation of such a circuit. 1200 w. Wis Engr—June, 1908. No. 93234 D.

See also Communication, under RAILWAY ENGINEERING, CONDUCTING TRANSPORTATION; and Train Despatching, under STREET AND ELECTRIC RAILWAYS.

Tele-Photography.

Seeing from Paris to Rome. An illustrated explanation of the principle of M. Armengaud's apparatus for seeing electrically at a distance. 1200 w. Sci Am—June 27, 1908. No. 93314.

The Electrical Transmission of Pictures (Transmission électrique des Images). M. Henry. A complete review of the principles and achievements in this field. Ills. 14000 w. Soc Belge d'Elecns—May, 1908. No. 93101 E.

DISTRIBUTION.

Alternating Circuits.

Vector Diagrams Applied to Polyphase Connections. Harold W. Brown. Aims to show by the use of vector diagrams the right connections for some of the more common polyphase circuits. 2500 w. Elec Jour—June, 1908. No. 93016.

We supply copies of these articles. See page 823.

Switch Boxes.

Easily Constructed Electrical Conduit and Service Boxes. T. C. Lerret. Illustrates and describes useful types of conduit and switch boxes. 1200 w. Elec Wld —June 6, 1908. No. 92774.

DYNAMOS AND MOTORS.

A. C. Dynamos.

A New Large Generator for Niagara Falls. B. A. Behrend. Illustrates and describes this generator which is remarkable on account of its speed of 300 rev. per min. 800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93237 D.

The Relative Proportions of Copper and Iron in Alternators. Carl J. Fechheimer. Gives a method which aims to enable the designer to determine what value of flux to employ to give the cheapest machine. 6000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93242 D.

A. C. Motors.

See Transformers, under TRANSMISSION.

Armature Testing.

Locating Grounds in Armature Coils. W. M. Hollis. Explains methods of finding the defective coil. 1200 w. Elec Wld —June 6, 1908. No. 92776.

Induction Motors.

Variable Speed Polyphase Induction Motors. R. H. Fenkhausen. Describes the connections and operation of these motors, their valuable features, etc. Ills. 1600 w. Power—June 9, 1908. No. 92904.

Induction Motors for Multi-speed Service with Particular Reference to Cascade Operation. H. C. Specht. Discusses mainly the characteristics and operation of two induction motors connected either in direct or in differential concatenation or as single motors. 3500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93236 D.

The Influence of the Flywheel in Induction Motor Operation (Ueber den Einfluss von Schwungmassen bei Induktionsmotorantrieben). Ludwig Kallir. Mathematical. Ills. 2500 w. Elektrotech u Maschinenbau—May 31, 1908. No. 93-174 D.

The Sudden Change of Hysteresis Loss in the Rotor of the Asynchronous Motors (Ueber die sprunghafte Aenderung der Hysteresisverluste im Rotor des Asynchronmotors). Hermann Zipp. A theoretical explanation. Ills. 4000 w. Elektrotech u Maschinenbau—May 24, 1908. No. 93173 D.

Rotating Field.

Graphical Treatment of the Rotating Field. R. E. Hellmund. Aims to evolve diagrams by means of which nearly all the phenomena of the rotating field may be easily studied. 4000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93240 D.

Standards.

British, American and German Standards for Electrical Apparatus. J. S. Peck. A brief comparison of the standard rules. 800 w. Elec Jour—June, 1908. No. 93014.

ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Fixation of Atmospheric Nitrogen —Cyanamide. A review of a lecture before the Faraday Soc. by Dr. Albert Frank, of Berlin, on the Frank-Caro process. 2000 w. Engng—June 12, 1908. No. 93326 A.

Cells.

The Cadmium Cell at a Low Temperature. Henry Tinsley. Remarks on observations made of their behavior at low temperatures. 1000 w. Elect'n, Lond—June 12, 1908. No. 93220 A.

The Mechanism of the Daniell Cell (Het Mechanisme van het Daniell-Element). E. Cohen, F. D. Chattaway, and W. Tombrock. A theoretical discussion. Ills. 9000 w. De Ingenieur—May 9, 1908. No. 93187 D.

Corrosion.

Rust: Its Formation and Prevention. M. Thornton-Murray. Abstract of paper read before the Birmingham Univ. Met. Soc. A review of the current theories on the formation of rust. 1500 w. Mech Engr—May 29, 1908. No. 92860 A.

Electro-Metallurgy.

See Refining, under MINING AND METALLURGY, COPPER; Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL; and Tin, under MINING AND METALLURGY, MINOR MINERALS.

Electro-Plating.

A Simple Method for Estimating the Quantity of Silver in Silver Plating Solutions. Detailed description of the volumetric sulphocyanate method. Ills. 3800 w. Brass Wld—June, 1908. No. 93053.

Review of 1907.

Recent Progress in Electro-Chemistry (Les récents Progrès en Electrochemie). C. A. Hofecker. A review of discoveries, advances, and publications during 1907. Serial. 1st part. 2000 w. Rev d'Electrochim et d'Electrométal—April, 1908. No. 93104 F.

ELECTRO-PHYSICS.

Electric Circuits.

The General Equations of the Electric Circuit. Charles P. Steinmetz. An attempt to investigate mathematically the phenomena which may occur in the most general case of an electric circuit. 13800 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93291 D.

We supply copies of these articles. See page 823.

Electricity.

Modern Theories of Electricity and Matter. Madame Curie. Abstract translation from *Revue Scientifique.* An explanation of modern theories. 3500 w. Sci Am Sup—June 20, 1908. Serial, 1st part. No. 93051.

Electrons.

The Dynamics of the Electron (La Dynamique de l'Electron). Henri Poincaré. An application of the ordinary dynamic laws to the electron theory. Ills. 16000 w. Rev Gen d Sci—May 30, 1908. No. 93106 D.

Magnetic Rays.

On the Probable Existence of a New Species of Rays (Magnetic Rays) Accompanying Discharge in a Magnetic Field. A. Righi. An account of observations and a proposed explanation. 1000 w. Elect'n, Lond—June 12, 1908. No. 93222 A.

GENERATING STATIONS.

Accumulators.

Performance of the Storage Battery and Its Relation to the Power Plant. W. B. Gump. Explains the performance of storage cells, the factors which determine the size of the battery to install and the fundamental considerations of an installation. 3000 w. Elec Rev, N Y —June 13, 1908. No. 92931.

Application of Storage Batteries to Regulation of Alternating-Current Systems. J. L. Woodbridge. Explains the advantages of a storage battery, and discusses the conditions to be met in the various a. c. systems. 7800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93241 D.

Balancers.

Balancers. Arthur Imbery. Explains the action of balancers. 1100 w. Elec Rev, Lond—May 29, 1908. No. 92864 A.

Central Stations.

Power Plant Development at Birmingham, Ala. Illustrates and describes extensive improvements in the main generating station of the Birmingham street railway. 2000 w. St Ry Jour—May 30, 1908. No. 92678.

Turbo-Generator Station in Seattle, Wash. Illustrated detailed description of the station and its equipment. 3300 w. Elec Wld—June 20, 1908. No. 93037.

An 11,000-Kw. Turbo-Generator Station in Seattle, Wash. Illustrated detailed description of a station recently put in service. 4500 w. Eng Rec—June 6, 1908. No. 92829.

Wimbledon Electricity Undertaking. H. Tomlinson Lee. An illustrated description of this high-pressure a. c., single phase system. 3500 w. Elec Engr, Lond—May 22, 1908. No. 92747 A.

The Central Station of the Electrical Company of the North of France (La Station Centrale d'Electricité de l'Energie électrique du Nord de la France). Ch. Dantin. Illustrated description of this large steam-turbine station. 4500 w. Génie Civil—May 23, 1908. No. 93130 D.

See also Turbine Plants, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Design.

Concerning Overload in Electrical Plant. C. Turnbull. Discusses the mistake of supplying an engine more powerful than its dynamo, and other points related to economical operation. 1000 w. Elec Engr, Lond—June 5, 1908. No. 92979 A.

Economics.

Meeting Gas and Gasoline Competition in Small Stores. Gives points brought out by J. R. Cravath in a talk at the convention of the Nebraska Elec. Assn. 2500 w. Elec Wld—June 6, 1908. No. 92778.

See also Centrifugal Pumps, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Hydro-Electric.

Water Power Development in the National Forests. A Suggested Government Policy. Frank G. Baum. Discusses the subject of royalties and outlines a government policy. 3500 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93293 D.

Hydro-Electric Development in Colorado. Lewis E. Ashbaugh. A report on the conditions and problems. Sketch maps. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93385 N.

Hydro Power Transmission. Harold J. Wright. Illustrates and describes the development on the Styx River, Hillgrove, N. S. W. 1700 w. Aust Min Stand—May 6, 1908. Serial, 1st part. No. 92883 B.

Hydro-Electric Plant of the La Crosse Water Power Company. George Merritt Ward. Illustrated description of a recent development in Wisconsin. 1600 w. Eng Rec—May 30, 1908. No. 92660.

The Hydro-Electric Power Plant of the Winchester & Washington City Railway Company. N. Wilson Davis. An illustrated account of a recently completed plant on the Shenandoah River. 2500 w. Eng Rec—June 20, 1908. No. 93063.

The Hydro-Electric Plant of the Great Northern Power Company. Arthur C. Ringsred. Illustrated description of a development on the St. Louis River, supplying power to Duluth and Superior. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93383 N.

Some Engineering Features of the

Southern Power Company's System. J. W. Fraser. Describes this system and the proposed extension, showing how conditions affect the design. Maps and Ills. 2800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93246 D.

A Modern American Low-Pressure Water Power Plant (Eine moderne amerikanische Niederdruck-Wasserkraftanlage). Guido E. Hemmeler. Begins an exhaustive description of the installations of the Southern Power Company. Ills. Serial, 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—May 30, 1908. No. 93199 D.

See Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Surge Tanks, and Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Operation.

Economical Operation of Small Generating Stations. Abstract of a paper by J. T. Whittlesey and Paul Spencer presented at the Chicago convention of the Nat. Elec. Lgt. Assn. Discusses the design and operation. 3500 w. Elec Wld—June 6, 1908. No. 92773.

Power Development in Small Stations. Charles Robbins and J. R. Bibbins. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Considers rates and how to increase the average load, giving a study of costs. 2000 w. Elec Rev, N Y—June 20, 1908. No. 93084.

Rates.

The Charges for Electrical Energy Supply in France. Georges Dary. Gives an idea of the general basis of rates in large towns. 1200 w. Elec Rev, Lond—June 19, 1908. Serial, 1st part. No. 93418 A.

Switchboards.

Operation of Large Hydro-Electric Station Switching Apparatus. F. E. Conrad. Considers important factors in the design, and discusses the operation. 4500 w. Elec Wld—May 30, 1908. No. 92689.

LIGHTING.

Arc Lamps.

Electric Illuminants and Their Efficiency. C. W. Kellogg, Jr. Read before the S. W. Elec. & Gas Assn. A discussion of efficiencies of arc and incandescent lamps, and the commercial considerations. 1700 w. Pro Age—June 1, 1908. No. 92764.

Electric vs. Gas.

Electricity or Gas?—The Problem of the Small Consumer. John D. Mackenzie. Discusses the objections urged against the use of electricity and explains a scheme of distribution. 2000 w. Elec Rev, Lond—June 12, 1908. Serial, 1st part. No. 93218 A.

European Practice.

Some Notes from Europe. Dr. Louis Bell. An account of different methods in use, especially in electrical equipments—lighting systems—etc. 2500 w. Elec Wld—June 27, 1908. No. 93307.

Illumination.

What Is Light? P. G. Nutting. An outline of the conditions which define light sensation in terms of radiation-power, discussing the three factors involved. Also editorial. 3500 w. Elec Wld—June 27, 1908. No. 93309.

The Number of Lamps for Uniform Illumination. Alfred A. Wohlauer. Gives convenient constants for use in determining the proper number and distribution of lighting units to obtain a desired effect. 1500 w. Elec Wld—June, 1908. No. 93312.

Incandescent Lamps.

An Incandecent Lamp Without a Vacuum. Information concerning the helion lamps. 1000 w. Sci Am—June 27, 1908. No. 93313.

High Voltage on Incandescent Lamps. Herbert S. Evans. Discusses the importance of using lamps rated at the voltage which is actually supplied. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93282 D.

Faulting of Tantalum Lamp Filaments. Interesting pictures reproduced from microscopic observations by M. D. Abbott, showing these filaments at different stages of service, with different types of current supply. 500 w. Elec Wld—June 27, 1908. No. 93310.

Recent Progress in Tungsten Metallic Filament Lamps. H. Hirst. Historical résumé of the development of metallic filament lamps, with particulars of tests of osram, wolfram, tantalum and carbon lamps, showing the saving effected. 9000 w. Inst of Elec Engrs—May, 1908. No. 92746 N.

Recent Improvements in Incandescent Lamps. J. T. Morris. A lecture delivered at the School of Military Engng. at Chatham. Principally a consideration of recent progress in metallic filament lamps. Ills. 2800 w. Bul Int Ry Cong—May, 1908. No. 93373 G.

See also Arc Lamps, under LIGHTING.

Street Lighting.

Street Lighting in the City of London. The report of A. A. Voysey, drawing comparisons between electric lighting and gas lighting. Also editorial discussion. 3800 w. Elect'n, Lond—June 5, 1908. No. 92981 A.

We supply copies of these articles. See page 823.

Theaters.

European Practice in the Electric Equipment of Theaters. Frank Koester. Illustrated description of details, calling attention to differences from American practice. 1200 w. Elec Rev, N Y—June 27, 1908. No. 93354.

Electrical Equipment of the Forrest Theater, Philadelphia, Pa. Illustrates and describes interesting details of a new theater and its electrical arrangements. 2000 w. Elec Wld—June 27, 1908. No. 93308.

MEASUREMENT.

Conductivity.

The Measurement of Electrical Conductivity. Rollo Appleyard. Gives a summary of results of an investigation indicating the principles applied in the design of direct-reading instruments for the measurement of electrical conductivity. 1800 w. Elec Rev, Lond—June 5, 1908. No. 92973 A.

Frequency.

See Tachometers, under MEASUREMENT.

Instruments.

The Use of Direct-Current Portable Testing Instruments. E. P. Peck. Information concerning the errors in direct-current meters, and the care needed in using these testing instruments. 2000 w. Elec Wld—June 6, 1908. No. 92775.

Insulator Testing.

The Testing of High-Voltage Line Insulators. C. E. Skinner. Presents for discussion a proposed specification as standard for the testing of such insulators. 2500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93244 D.

Meter Calibration.

Calibration of Watt-Hour Meters. Joseph B. Baker. Directions for making the necessary adjustments. 2000 w. Elec Wld—June 27, 1908. No. 93311.

Meter Inspection.

General Inspection and Repairing of Service Meters. Joseph B. Baker. Considers electrical troubles of commutator meters and their remedies. 4000 w. Elec Wld—June 20, 1908. No. 93039.

Meters.

The Chauvin and Arnoux Portable Direct-Reading Wattmeter (Wattmètre de Précision portatif et à Lecture directe de MM. Chauvin et Arnoux). M. Aliamet. Illustrated description. 2400 w. L'Elecn —May 2, 1908. No. 93109 D.

Meter Testing.

Meter Laboratory of the Birmingham (Ala.) Railway, Light & Power Company. Brief illustrated description. 700 w. Elec Wld—June 20, 1908. No. 93038.

Potentiometers.

Potentiometer Design. Joseph H. Hart. Explains the potentiometer method of measuring electromotive force, the general designs and special applications for convenience and accuracy. 1500 w. Elec Rev, N Y—June 13, 1908. No. 92930.

Tachometers.

Resonance Instruments for the Distant Measurement of Revolutions and Frequency (Resonanzinstrumente zur Fernmessung von Umlaufzahlen und Frequenzen). Kurt Seidl. Illustrated description of various types. 2300 w. Glückauf—May 9, 1908. No. 93150 D.

Units.

The Absolute Value of the Ampere. A review of two recent papers before the Royal Society of London. "A New Current Weigher, etc.," by Messrs. Ayrton, Mather & Smith, and "The Silver Voltameter," by Messrs. Smith, Mather & Lowry. Also editorial. 5200 w. Elec Rev, N Y—June 6, 1908. No. 92796.

TRANSMISSION.

Insulators.

Electrical Porcelain. H. W. Brady. Abstract of a paper read before the Birmingham Dist. Elec. Club. Gives a classification and description of clays, discussing vitreous insulators for outdoor work and their manufacture. 3500 w. Mech Engr—May 29, 1908. Serial, 1st part. No. 92861 A.

Insulation of High Tension Transmission Lines. Francis S. Denneen. Abstract of paper read before the Cent. Elec. Ry. Assn. Considers the action of an insulator when subject to electrical stress, discussing the theory of insulator design and performance. 3500 w. St Ry Jour—May 30, 1908. No. 92681.

See also Insulator Testing, under MEASUREMENT.

Lightning.

Critical Study of Lightning Records on Taylor's Falls Transmission Line. Percy H. Thomas. Analyses of the paper punctures. 9000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93294 D.

Lightning Protection.

Measurements of Lightning, Aluminum Lightning-Arresters, Earth Resistances, Cement Resistances, and Kindred Tests. E. E. F. Creighton. Describes briefly the instruments and methods used in the measurements, and the theory and practice of lightning protection. Ills. 18600 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93238 D.

Line Construction.

See Telephone Lines, under COMMUNICATION.

Line Design.

Fundamental Considerations Governing the Design of Transmission-Line Structures. D. R. Scholes. Briefly considers forces due to wind, sleet, low tempera-

ture, etc. 2500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93243 D.

Lines.

The 27,000-Volt Transmission System of the Obermatt Power Plant in Switzerland. Illustrated description of this high-tension transmission line, supplying Lucerne and vicinity. 1200 w. Elec Rev, N Y—June 13, 1908. No. 92928.

Electric Power Development on the Rio Grande Border. W. D. Hornaday. An account of the proposed transmission lines in N. & S. Laredo to operate pumping plants for irrigating the onion-growing districts of Texas. 1800 w. Elec Wld—June 6, 1908. No. 92771.

Distribution in Suburban Districts. George H. Lukes. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Discusses details of line construction, substations, transformers, local systems, secondary distribution, etc. 4000 w. Elec Rev, N Y—June 13, 1908. No. 92929.

Losses.

High Voltage Measurements at Niagara. Ralph D. Mershon. A report of investigations on transmission losses, and results, especially the work at Niagara Falls. Ills. 10500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93245 D.

Protective Devices.

Switchgear Control Apparatus and Relays for Alternating-Current Circuits. Charles C. Garrard. Deals with instances where systems are designed on erroneous lines, and discusses other systems of control. 6000 w. Inst of Elec Engrs—May, 1908. No. 92866 N.

Protective Relays.

Alternating-Current Automatic Relays of Brown, Boveri and Co. (Relais automatiques Brown, Boveri et Cie. pour Courant alternatifs). L. A. David. Illustrated description of several types. 2500 w. L'Elecn—May 9, 1908. No. 93110 D.

Rotary Converters.

A New Type of Rotary Converter. H. L. Lincoln. Describes a split-pole converter produced by the General Electric Co. 900 w. Harvard Engng Jour—June, 1908. No. 93022 D.

The Sectional Pole Rotary Converter. Joseph L. Burnham. Describes these machines, which do not require any auxiliary apparatus for obtaining a variable d. c. voltage. Ills. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93276 D.

Voltage Ratio in Synchronous Converters with Special Reference to the Split-Pole Converter. Comfort A. Adams. Gives a theoretical analysis with the object of showing how the field distortion of a split-pole converter does not necessarily involve electromotive force distortion. 6600 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93239 D.

Substations.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Effect of Wave Form on the Core Losses of a Constant Potential Transformer. Fred H. Kroger. Experimental investigation. 700 w. Jour of Engng, Univ of Colo—No. 4. No. 93289 D.

Multiple Operation of Transformers. Royal W. Sorensen. Calls attention to some of the conditions that govern their operation, showing the simplicity of the problem. 1600 w. Jour of Engng, Univ of Colo—No. 4. No. 93286 D.

Leakage in Alternating-Current Transformers and Commutator Motors (Die Streuung bei Wechselstromtransformatoren und Kommutatormotoren). W. Rogowski and K. Simons. Mathematical and theoretical. Ills. Serial, 1st part. 3200 w. Elektrotech Zeitschr—May 28, 1908. No. 93184 D.

Voltage Drop.

Graphical Determination of Voltage Drop in Direct-Current Feeders. R. W. Stovel and N. A. Carle. Gives a diagram to facilitate calculations, explaining its use. 1200 w. Elec Jour—June, 1908. No. 93015.

Voltage Regulation.

Automatic Regulating Devices (Automatische Reguliervorrichtungen). Paul Thieme. Illustrates and describes several types of automatic switches. 2500 w. Elektrotech Zeitschr—May 28, 1908. No. 93185 D.

The Thury Automatic Regulators (Régulateurs automatiques Système R. Thury). J. A. Montpellier. Describes the construction and operation of types for use with direct and alternating currents. Ills. 3500 w. L'Elecn—May 30, 1908. No. 93112 D.

The Theory of the Tirril Regulator (Zur Theorie des Tirrill-Regulators). A. Schwaiger. Discusses the theory statically and dynamically. Ills. 2500 w. Elektrotech u Maschinenbau—May 17, 1908. No. 93172 D.

MISCELLANY.

A. C. Problems.

A Minimum Work Method for the Solution of Alternating-Current Problems. Harold Pender. Explains this new method and gives the solution of a number of problems. 3500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93235 D.

Weather Bureau.

Electricity in the United States Weather Bureau. Day Allen Willey. An illustrated article showing how extensively electricity is used in this branch of government service. 2500 w. Elec Rev, N Y—June 6, 1908. No. 92795.

We supply copies of these articles. See page 823.

INDUSTRIAL ECONOMY

Apprenticeship.

The Apprenticeship System of To-Day. W. R. Warner. Read before the Nat. Soc. for Pro. of Ind. Ed. A discussion of the system. 1500 w. Ir Age—June 4, 1908. No. 92725.

Student Engineers and Their Work. Edward J. Cheney. Describes the training at the Schenectady Works of the General Electric Co., available for student engineers. 4000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93381 N.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This third article of a series discusses the profitable use of cost comparisons. 1500 w. Engineering Magazine—July, 1908. No. 93402 B.

Uniform Foundry Costs. A chart showing the distribution of labor, materials and burden, with extracts from the report submitted at the Toronto meeting of the Am. Found. Assn. 3500 w. Ir Age—June 25, 1908. No. 93301.

Depreciation.

Depreciation. Edwin S. Mack. Read before the Wisconsin Gas Assn. On the subject of depreciation in relation to public utilities. General discussion. 6500 w. Am Gas Lgt Jour—June 8, 1908. No. 92825.

Education.

Problems of Industrial Education. George Frederic Stratton. A critical discussion of the methods of manual training in the public schools, and of the general subject of apprenticeship. 3500 w. Cassier's Mag—June, 1908. No. 92997 B.

Engineering in Public Schools. Editorial discussion averse to teaching mechanical engineering in public schools, but favorable to the teaching of handicraft. 3000 w. Engng—June 12, 1908. No. 93227 A.

Machine-Tool Design in an Engineering Course. E. H. Fish. Describes work of the students of the Worcester Polytechnic Institute. 2200 w. Am Mach—Vol. 31, No. 25. No. 93034.

The New Method of Training Engineers. Magnus W. Alexander. Outlines briefly the system evolved by the General Electric Co. in the works at Lynn, Mass., and urges the coöperation of works and college to give the education needed. 5000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93247 D.

Modern Ideals in Mechanical Engineering Education. Walter Rautenstrauch. A critical discussion of mechanical engineering educational systems and the present requirements. 6000 w. Engineering Magazine—July, 1908. No. 93401 B.

The Academic Training of Mechanical Engineers in America and England (Die akademische Ausbildung der Maschinen-ingenieure in Nordamerika und England). Dr. Alexander Lang. A general review of the methods and curricula of mechanical-engineering education. 9000 w. Zeitschr d Ver Deutscher Ing—May 30, 1908. No. 93198 D.

The Development of Mechanical Engineering Training (Die Entwicklung des maschinen-technischen Studiums). A. Riedler. An important paper on conditions in Germany, with discussion. Ills. 23600 w. Zeitschr d Ver Deutscher Ing—May 2, 1908. No. 93181 D.

Eight-Hour Day.

Miners' Eight Hour Question. T. Good. Discusses the influence of the eight-hour rule on British industry. 2500 w. Cassier's Mag—June, 1908. No. 93001 B.

Engineering.

Engineering Personality and Organization. Walter C. Kerr. An address before the graduating class of Rensselaer Polytechnic Inst. 4000 w. Eng Rec—June 20, 1908. No. 93064.

Engineering Opportunities.

Opportunities for Young Technical Graduates in the United States. A discussion by authors residing in the East, West, and South. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93384 N.

Industrial Development.

The Principles of Industrial Exploitation (Principes d'Exploitation industrielle). Max Furney. Outlines the circumstances which have favored the development of the industrial centres of France. Tables. 3000 w. Rev d'Econ Indus—May 16, 1908. No. 93100 D.

Industrial Legislation.

French Industry and the New Social Laws (L'Industrie Française et les nouvelles Lois sociales). René Duchemin. Discusses the effects of the employers' liability law, the weekly day of rest, and other recent acts. 3000 w. Génie Civil—May 9, 1908. No. 93126 D.

Management.

Recording and Accounting for Time. Oscar E. Perrigo. Ninth of a series of articles on shop management and cost keeping. 4500 w. Ir Trd Rev—June 4, 1908. No. 92785.

We supply copies of these articles. See page 823.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. The present number discusses typical inefficiencies and their significance. 3500 w. Engineering Magazine—July, 1908. Serial, 1st part. No. 93395 B.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This fourth and last article of a series discusses methods of securing better deliveries. 2500 w. Engineering Magazine—July, 1908. No. 93396 B.

Shop Order Tracing System. Charles M. Pond. Presents a system of chief interest to the manufacturer of tools, instruments, fixtures, and the like. 2500 w. Mach, N Y—June, 1908. No. 92697 C.

See also same title, under RAILWAY ENGINEERING, MISCELLANY.

New Zealand.

Industrial Conditions in New Zealand. J. J. Flather. Gives results of personal observations during an extensive tour in 1907. Ils. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93386 N.

Patents.

Foreign Abuse of Our Patent Law. Editorial discussion of new patent legislation in England, and the foreign criticism of the "compulsory working" clause. 1800 w. Engng—May 8, 1908. No. 92499 A.

Patents and Inventors. E. C. Smith. An explanation of some of the difficulties and essentials. 2500 w. Mach, N Y—June, 1908. No. 92695 C.

Patent-Office Contests Between Rival Claimants to an Invention. Edwin J. Prindle. Supplementary to a series of articles concluded in the Dec. issue. Discusses the law of interferences and principles of its application. 4500 w. Engineering Magazine—July, 1908. No. 93400 B.

Stores Keeping.

See Stores Departments, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Sweden.

Mining and Industrial Progress in Sweden. John Geo. Leigh. A survey of the important engineering enterprises under consideration is given. Ills. 5000 w. Engineering Magazine—June, 1908. No. 93393 B.

Wages.

See Management, under INDUSTRIAL ECONOMY.

MARINE AND NAVAL ENGINEERING

Battleships.

The New Method of Trying Battleships. An account of the trials required and tests made. Ills. 2000 w. Sci Am—June 13, 1908. No. 92907.

The Cult of the Monster Warship. William H. White. Discusses the increase in size and cost of recent warships, giving arguments for and against the new types. 11000 w. Nineteenth Cent—June, 1908. No. 93060 D.

Buoys.

Buoys and Beacons. Max Buchwald. Illustrates and describes various forms, explaining their purposes. 2500 w. Sci Am Sup—May 30, 1908. No. 92659.

Cruisers.

H. M. S. "Indomitable." Illustration, with notes on power, speed, etc. 1000 w. Engng—May 29, 1908. No. 92873 A.

The British "Dreadnought" Cruisers. Percival A. Hislam. Illustrates and describes the "Indomitable," one of the vessels of this class. 1000 w. Sci Am—May 30, 1908. No. 92656.

Dredges.

An Electrically Operated Dredge. Illustrates and describes an electrically driven suction dredge in use on the coast of California. 2500 w. Eng Rec—June 6, 1908. No. 92827.

A 5½ Foot Dredger with Two Trommels. D. Zicks. Describes a dredge built by the Poutiloff Works Co., Russia, for gold recovery. Ills. 6000 w. Min Jour—May 30, 1908. No. 92871 A.

See also Dredging, under MINING AND METALLURGY, GOLD AND SILVER.

Drydocks.

A Clever Substitute for a Drydock. H. M. Masdell. Illustrated description of caissons built to take the place of a drydock on Lake Ontario, for repairing a twin-screw steamer. 700 w. Sci Am—June 27, 1908. No. 93317.

Electric Power.

The Propelling Power of the Future. J. H. Biles. Discusses means of obtaining the full efficiency of turbines, describing the Mavor system of electric transmission for steam turbines. 2400 w. Marine Rev—May 28, 1908. No. 92686.

Fire Boats.

Fire-Fighting Tugboats. R. H. Newbern. Practical suggestions for converting tugboats into fireboats. 2500 w. Ins Engng—June, 1908. No. 93361 C.

New Fire Boats for New York. An account of the "James Duane" and "Thomas Willett," equipped with turbine-driven centrifugal pumps. 1200 w. Naut Gaz—June 11, 1908. No. 92921.

We supply copies of these articles. See page 823.

Model Basins.

Towing Tank at the University of Michigan. Day Allen Willey. Illustrated description of a tank for experimental work with ship models. 1500 w. Sci Am —June 13, 1908. No. 92908.

Models.

The Art of Marine Model Making. Illustrates various types of models and gives an account of fine work in their construction. 1000 w. Marine Rev—June 4, 1908. No. 92805.

Motor Boats.

The British Challenger for the Harmsworth Motor-Boat Trophy—A 400-Horse-Power Racing Craft. Illustrated description. 1500 w. Sci Am—June 13, 1908. No. 92910.

Piping.

The Protection of Ship Piping from Corrosion (Schutzmittel zur Verhinderung von Rohranfressungen auf Schiffen). Herr Schirmer. An illustrated discussion of the utility of various materials and methods. 1600 w. Schiffbau—May 27, 1908. No. 93156 D.

Propellers.

The Laying Out of Propeller Wheels. Charles S. Linch. Discusses the design and development. Ills. 1800 w. Int Marine Engng—July, 1908. Serial. 1st part. No. 93211 C.

Rudders.

The Evolution of the Rudder. Orlando Sumner. A brief review of the history and development, considering the effect of rudders upon fast power boats. 2000 w. Rudder—June, 1908. No. 92765 C.

Shipbuilding.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Ship Design.

Limitations Upon Ship Design. Bryson Cunningham. The principal difficulty is in regard to available depth of water. 1200 w. Marine Rev—June 4, 1908. No. 92806.

A New System of Ship Construction. J. W. Isherwood. Illustrated description of a new system of framing. 5000 w. Marine Rev—June 4, 1908. No. 92803.

Notes on the Form of High-Speed Ships. A. E. Long. A study of forms that may be used, with general discussion. 3 plates. 9000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1908. No. 93270 N.

Two Notes on Ship Calculations. W. S. Abell. Read before the Inst. of Naval Archts. The first note consists of a discussion of methods used, including a new rule for finding areas, etc., with a considerably less number of ordinates than usual. The second note gives a method of constructing an approximate metacentric diagram. 5000 w. Engng—June 5, 1908. No. 92988 A.

Ship Heating.

The Heating of Modern Ocean Liners. W. Carlile Wallace. Read before the Inst. of Naval Archts. Discusses the systems recently installed, favoring a system similar to that used on the Lusitania, combined with a system of electric heating under automatic control. 4500 w. Engng—June 12, 1908. No. 93229 A.

Steamboats.

A Survey Steamer for the Russian Government. Brief illustrated description of the Oxotckb. 200 w. Engr, Lond —May 29, 1908. No. 92881 A.

Steam Engines.

Marine Engine Design. Edward M. Bragg. Considers the main points of marine engine design, and the desirability of systematic data-keeping. 3000 w. Int Marine Engng—July, 1908. Serial. 1st part. No. 93208 C.

Steamships.

A Magnificent Lake Freight Steamship. Illustrated description of the Wilpen. 1000 w. Naut Gaz—June 4, 1908. No. 92781.

The Americo-Italian Emigrant Steamer Ancona. Benjamin Taylor. Illustrated detailed description. 700 w. Int Marine Engng—July, 1908. No. 93207 C.

New Holland-American Royal Mail Liner Rotterdam. Describes this large twin-screw steamer. 2500 w. Marine Rev —June 18, 1908. No. 93085.

New Japanese Transpacific Liners. Illustrated description of the largest ships ever built in Japan, and the first so built to be fitted with steam turbines, for service between Japan and San Francisco. 1200 w. Int Marine Engng—July, 1908. No. 93206 C.

Steam Turbines.

The Turbine Question. Henry Penton. A comparison of the turbines and reciprocating engines from the viewpoint of steam efficiency. 3000 w. Marine Rev—June 4, 1908. No. 92804.

Practical Experience with Marine Steam Turbines. Discusses some of the defects and some things of importance to avoid trouble. Ills. 2000 w. Int Marine Engng—July, 1908. No. 93209 C.

See also Electric Power, under MARINE AND NAVAL ENGINEERING.

Steering Gears.

The Control of Steam Steering Engines by Electric Motors (Ueber den elektromotorischen Antrieb des Wechselshiebers der Dampfrudermachine). A. Stauch. Describes several systems in use. Ills. 3000 w. Schiffbau—May 13, 1908. No. 93155 D.

We supply copies of these articles. See page 823.

Submarine Signalling.

The Development of Submarine Signalling. Robert G. Skerrett. Illustrates and describes electrical methods of communicating at sea. 2200 w. Cassier's Mag—June, 1908. No. 93000 B.

Torque.

Torque of Propeller Shafting: Some Investigations and Results. J. Hamilton Gibson. Read before the Inst. of Naval Archts. Discusses the application of torsion meters to propeller shafting, and describes the "Flashlight" torsion meter. 2200 w. Mech Engr—June 19, 1908. No. 93415 A.

U. S. Navy.

Admiral Evans's Report of the Needs of Our Ships. Editorial review of this report and its recommendations. 1200 w. Sci Am—June 13, 1908. No. 92905.

MECHANICAL ENGINEERING

AUTOMOBILES.

Chalmers New Detroit.

Chalmers New Detroit. Illustrated description of a new car of the E. R. Thomas Detroit Co. Commends the unit power plant. 1200 w. Automobile—June 11, 1908. No. 92924.

Commercial Vehicles.

Commercial Motor-Vehicles. A general discussion of their constructive features, motive power, and of points needing improvement. 4000 w. Engng—May 29, 1908. No. 92874 A.

The Berliet Motor Trucks (Camions automobiles, Système Berliet). A. Le Vergnier. Illustrated description, with details of costs of operation. 2200 w. Génie Civil—May 16, 1908. No. 93127 D.

The Construction and Economic Importance of Motor Omnibuses and Trucks (Bauart und wirtschaftliche Bedeutung der Motoromnibusse und Lastwagen). A. Hofmann. A review of their progress and present status. Ills. Serial. 1st part. 4800 w. Zeitschr d Mit Motorwagen Ver—May 15, 1908. No. 93157 D.

Tests of Motor Vehicles Carried Out by the Berlin Fire Department (Bericht über Versuche mit Kraftfahrzeugen bei der Berliner Feuerwehr von Branddirektor Reichel). A description of tests carried out during the past two years, giving results and conclusions. Serial. 1st part. 4000 w. Zeitschr d Mit Motorwagen Ver—May 31, 1908. No. 93158 D.

Construction.

Three Uncommon Bodies. Illustrated descriptions of types of comparatively short bodies. 2000 w. Autocar—May 30, 1908. No. 92858 A.

Driving Axles.

Simplifying Transmission of Power on an Auto. L. M. Dietrich. Illustrated description of the Dietrich universal automobile driving axle, explaining its principle. 1000 w. Automobile—June 4, 1908. No. 92780.

Farm Motors.

The Modern Farmer's Tireless Horse. Frank C. Perkins. Concerning uses to which the gasoline traction engine is being applied on American farms. Ills. 1200 w. Sci Am—June 27, 1908. No. 93315.

The Gasoline Tractor of the Future. George G. McVicker. Illustrated discussion of farm tractors for use in the west and southwest. 900 w. Gas Engine—June, 1908. No. 92728.

Fuels.

Petrol and Petrol Tests. G. H. Baillie. Read before the Roy. Auto. Club. Discusses the extent to which the fuel can be utilized, its condition, etc., giving a report of tests. 2500 w. Auto Jour—May 23, 1908. Serial. 1st part. No. 92737 A.

Ignition.

Ignition Cell Charging Plant. Fourd Ely. Describes the apparatus installed at the Dumfries Elec. Works. 900 w. Elec Engr, Lond—May 22, 1908. No. 92748 A.

Lorraine Dietrich.

The 20-30 H. P. Lorraine Dietrich. Illustrated description; the present number considering the engine and its control, the carburetter, and ignition. 1800 w. Autocar—June 6, 1908. Serial. 1st part. No. 92968 A.

Lubrication.

Lubrication on the Modern Automobile. Arthur H. Denison. Concerning the kind of oil required, the effect of poor lubrication, care in oiling, etc. Diagrams. 3500 w. Automobile—June 11, 1908. No. 92923.

Packard.

Packard's "Thirty," 1909. Illustrated description of this new model. 2000 w. Automobile—June 25, 1908. No. 93353.

Siddeley.

The 14 H. P. Siddeley Four-Cyl. Car. Illustrated detailed description. 1800 w. Autocar—May 23, 1908. No. 92738 A.

Silvertown.

Silvertown Electric Cars. Illustrated detailed description. 700 w. Autocar—May 30, 1908. Serial. 1st part. No. 92859 A.

We supply copies of these articles. See page 823.

Sleds.

Automobile Sled for Dr. Charcot's Expedition. Illustrates and describes a motor sled built for exploration of the Antarctic regions. 1200 w. Sci Am—May 30, 1908. No. 92655.

Spa.

The Spa Petrol Cars. Illustrated detailed description of this 60-h. p. Italian car. 1200 w. Auto Jour—May 30, 1908. Serial. 1st part. No. 92856 A.

COMBUSTION MOTORS.

Gas Engines.

Pre-ignition in Gas Engines. W. H. Booth. Discusses the causes. 1200 w. Can Engr—June 5, 1908. No. 92835.

Gas Engine Development Problems. Henry Harrison Suplee. Gives facts proving the reliability of the internal-combustion motor. 2500 w. Cassier's Mag—June, 1908. No. 93005 B.

Getting the Burned Gases Out of an Engine Cylinder. H. Addison Johnston. Gives diagrams and discusses the designing of exhaust valve cams, and other devices for providing a quick means of escape for the gas. 1500 w. Power—June 2, 1908. No. 92699.

The Present Status of the Gas Engine. H. D. Frary. Shows how obstacles that stood in the way of progress have been overcome, and discusses the advantages and disadvantages of the two-cycle engine. 2200 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93390 N.

See also Power Plants, under POWER AND TRANSMISSION.

Gasoline Engines.

The Schiske Aerial Petrol Motor. Photographs, drawings and description of the new features. 700 w. Auto Jour—May 30, 1908. No. 92857 A.

See also Power Plants, under POWER AND TRANSMISSION.

Gas Power Plants.

Gas Power Station at the Humber Company's Works. Illustrated description of a suction gas plant of eight gas engines with their separate suction gas producers, planned in such a way that any number or the whole can be used at once. 1000 w. Engr, Lond—May 29, 1908. No. 92878 A.

A Satisfactory Producer-Gas Plant. F. C. Tryon. An account of a factory plant in Brooklyn, N. Y., its operation and cost. 2200 w. Power—June, 1908. No. 92891.

Power Plant Operation on Producer Gas. Godfrey M. S. Tait. Discusses various types and arrangements, the difficulties met, experiments made, and information relating to operation. Ills. 3000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93254.

See also Pumping Plants, under HYDRAULIC MACHINERY; and Power Plants, under POWER AND TRANSMISSION.

Gas Producers.

Gas Producer Operation. Frank P. Peterson. A criticism of article by A. S. Atkinson in the May 12th issue of this paper. 1800 w. Power—June 16, 1908. No. 92996.

Gasification of Low Grade Fuels. L. G. Findlay. Abstract of a paper read before the Ohio Soc. of Mech., Elec. & Steam Engrs. Brief consideration of gas producers and the by-product oven. 1000 w. Power—June 23, 1908. No. 93096.

Gas Turbines.

Gas Turbines (Die Gasturbinen). Giuseppe Belluzzo. An abstract translation of a paper read before the Milan Society of Engineers and Architects. Ills. 2500 w. Serial. 2 parts. Zeitschr f d Gesamte Turbinenwesen—May 9 and 20, 1908. No. 93178 each D.

Oil Engines.

Notes on the Internal-Combustion Motor (Alcune Osservazioni sopra i Motori a Combustione interna). U. Bordoni. Refers particularly to the Diesel motor. Ills. 6500 w. Ann d Soc d Ing e d Arch Ital—May, 1908. No. 93133 F.

See also Pumping Engines, under HYDRAULIC MACHINERY; and Power Plants, under POWER AND TRANSMISSION.

HEATING AND COOLING.

Air Drying.

The Dehydration of Air. Joseph H. Hart. Examines methods of removing the moisture from air and applications made of the processes. 1800 w. Cassier's Mag—June, 1908. No. 92999 B.

Air Humidifying.

The Construction and Ventilation of a Weave Shed. Address before the Nat. Cotton Mfrs. Assn. Describes the building and the direct system of radiation adopted, the humidifying arrangements, etc. Ills. 1200 w. Heat & Vent Mag—June, 1908. No. 93029.

The Humidifying and Cooling of Air in Factories (Zur Frage der Luftbefeuchtung und Kühlung in Fabriken). E. Kronig. An elaborate paper giving many cost data. 12000 w. Gesundheits-Ing—May 2, 1908. No. 93169 D.

Central Plants.

Heating and Power Plant at Princeton Theological Seminary. Illustrates and describes a plant for a group of buildings already constructed, showing how a modern system of steam heating was adapted. 1300 w. Heat & Vent Mag—June, 1908. No. 93027.

Electric Heating.

Notes on the Electric Heating Plant of the Biltmore Estate. Charles E. Waddell.

States the reasons for the substitution of electricity for fuel and gives a detailed description of the systems. Ills. 3000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93292 D.

Hot-Air Heating.

Heating and Ventilation of a Large Retail Store in San Francisco. Describes an interesting equipment of indirect heating by hot blast and exhaust ventilation. Ills. 2500 w. Eng Rec—June 6, 1908. No. 92828.

Hot-Water Heating.

The Calculation of Pipe Lines for Hot-Water Heating (Zur Berechnung der Rohrleitungen von Warmwasserheizanlagen). Criticisms of a paper by M. Haller by Herrn Dietz and Krell, with replies by Herr Haller. 2200 w. Gesundheits-Ing—May 2, 1908. No. 93170 D.

Refrigeration.

Air Cooling Problems. F. E. Matthews. How to calculate the amount of refrigeration needed. 1200 w. Power—June 9, 1908. No. 92903.

Fallacies of Refrigerating Theory. H. Rassbach. Discusses the principles involved in the change from the liquid to the gaseous form. 1800 w. Ice & Refrig—June, 1908. Serial. 1st part. No. 92798 C.

Mechanical Production of Low Temperatures. Sydney F. Walker. Considers the part the temperature of the refrigerant plays, and how the temperature of the cooling water affects the work of the engine or motor. 2500 w. Power—June 23, 1908. No. 93095.

A Modern Ice Making and Refrigerating Plant. Details of plan and construction of a 100-ton plant in Columbus, Ohio, and its equipment. 2500 w. Ice & Refrig—June, 1908. No. 92797 C.

Daily Routine in an Ice Plant. William S. Luckenbach. Considers points to be observed to realize the best economy. 2000 w. Power—June, 1908. No. 92888.

Electric Refrigeration in Philadelphia. John Meyer and R. L. Lloyd. Facts in regard to the experience in obtaining and retaining this class of business in the city named. Ills. 2500 w. Elec Wld—June 6, 1908. No. 92772.

How a Refrigerating Plant Was Remodeled. Warren O. Rogers. Deals with a refrigerating plant in a packing house where electric equipment was discarded and gas engines substituted, resulting in improved efficiency. 800 w. Power—June, 1908. No. 92889.

Steam Heating.

See Central Plants, under HEATING AND COOLING.

Ventilation.

See Hot-Air Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Air Lifts.

Test of an Air-Lift Pumping Plant and Experimental Studies of Air-Lift Pumps. Describes the tests made at Atlantic City, N. J., and a series of experiments made by the Westinghouse Air Brake Co. 3000 w. Eng News—June 18, 1908. No. 93044.

Experiments with Air-Lifts. An account of the series of tests made on a driven well at Wilmerding, Pa., to determine the amount of water raised, air required and other conditions relative to pumping by direct air-pressure. 2000 w. Eng Rec—June 13, 1908. No. 92949.

Centrifugal Pumps.

The Motor-Driven Centrifugal Pump as a Central-Station Load. E. N. Percy. Points out the opportunities for a motor load for central stations presented by the use of such apparatus. 1800 w. Elec Wld—June 6, 1908. No. 92779.

See also Fire Boats, under MARINE AND NAVAL ENGINEERING.

Pumping Engines.

Notes on Two Recent Tests of Fuel Oil Pumping Engines. Describes the plants and conditions, and the tests made at Wrentham and at Wareham, Mass. 2000 w. Eng Rec—June 13, 1908. No. 92956.

Pumping Plants.

The Suction Gas-Producer Pumping Plant at Westford, Mass. Illustrated detailed description of a plant of the Westford Water Co. 1200 w. Eng Rec—May 30, 1908. No. 92664.

Operating Results of the Producer-Gas Pumping Plant at St. Stephen, N. B. Information from a paper by F. A. Barbour, giving results of a test of the equipment. Ills. 4000 w. Eng Rec—June 6, 1908. No. 92830.

The Testing of Pumping Plants (Ueber Untersuchungen an Wasserhaltungsanlagen). A description of a weir devised by Sulzer Brothers for the measurement of large discharges of water with results of its use. Ills. 2500 w. Glückauf—May 2, 1908. No. 93149 D.

See also Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Nevada, under MINING AND METALLURGY, GOLD AND SILVER.

Pump Valves.

The Action of Automatic Pump Valves (Das Verhalten selbsttätiger Pumpenventile unter Voranssetzung des "Schwebezustandes"). H. Sieglerschmidt. Theoretical and mathematical. Curves. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—May 16, 1908. No. 93182 D.

Rams.

An Investigation of the Hydraulic Ram. Leroy Francis Harza. Investigations made to derive general mathematical laws

which shall apply to all single-acting hydraulic rams under all conditions of use; and to show that the formulae are justified. Ills. 12000 w. Bul Univ of Wis, No. 205—March, 1908. No. 93366 C.

Suction Pipes.

The Design of Suction Pipes. James Anderson. Read before the Inst. of Marine Engrs. Discusses the theoretical side of the subject showing how the design is modified by the various conditions. 3000 w. Mech Wld—May 29, 1908. No. 92855 A.

Surge Tanks.

The Surge Tank in Water Power Plants. Raymond D. Johnson. A mathematical determination of the economical proportions of a device for aid in speed regulation and pressure relief in water power, with long pressure pipes and high velocities. 8000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93257 C.

Turbine Plants.

A Device to Increase the Effective Head of a Water Power Plant by Utilizing Waste Water. Describes Clemens Herschel's "fall increaser" designed to increase the effective head of turbine plants by the use of freshet water going to waste Ills. 400 w. Eng News—June 11, 1908. No. 92940.

The Fall-Increaser. Clemens Herschel. An account of experiments on negative pressure: made at the public testing flume of the Holyoke Water Power Co., with an apparatus designed to increase the fall acting on hydraulic turbines in cases of a low fall, when caused by back water; or, when existing naturally with a plentiful supply of water, for the purpose of increasing the speed. Ills. 3500 w. Harvard Engng Jour—June, 1908. No. 93021 D.

Turbines.

The Scope of Application of Turbines Built on the Usual Systems (Verwendungsbereich der im modernen Turbinenbau üblichen Turbinensysteme). Herr Holl. Discusses mathematically the various types of water turbines, beginning with the Francis. Ills. Serial. 1st part. 3500 w. Zeitschr f d Gesamte Turbinenwesen —May 20, 1908. No. 93179 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Resistance of Balls and Rollers (La Résistance des Billes et des Rouleaux). Maurice Koechlin. A mathematical paper deriving formulae and giving tables of results. Ills. 2500 w. Génie Civil —May 9, 1908. No. 93125 D.

Clutches.

The Wheeling Electric Induction Clutch. Illustrated description, with statement of advantages and applications. 2500 w. Ir Age—June 11, 1908. No. 92894.

Drafting.

See Management, under RAILWAY ENGINEERING, MISCELLANY.

Graphical Statics.

The Circle of Stress. M. Linenthal. An explanation of this graphical method for solving problems of internal stress. 700 w. Harvard Engng Jour—June, 1908. No. 93024 D.

Moments of Inertia.

Deduction and Application of Moment of Inertia. Mathematical explanation. 1000 w. Prac Engr—June 19, 1908. Serial. 1st part. No. 93414 A.

Rotating Discs.

Forms of Equal Strength with Special Reference to Rotating Discs (Ueber Formen gleicher Festigkeit mit besonderer Berücksichtigung der rotierenden Scheiben). Alfons Leon. An illustrated mathematical discussion. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver —May 1, 1908. No. 93159 D.

Screws.

Comparison of Screw Thread Standards. Amasa Trowbridge. Gives a diagram used to study the problem, with remarks. 300 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93253.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

Helpful Hints for Boiler Makers. Charles Dougherty. Hints from the West Albany shops of the N. Y. C. & H. R. R. R. Gives a diagram for finding the length of rivets, and illustrates various tools and an oil burner. 500 w. Boiler Maker—June, 1908. No. 93008.

Boring Machines.

Large Turning and Boring Mill. Illustrated description of an unusually large machine built at Manchester, Eng. 500 w. Engr, Lond—May 29, 1908. No. 92880 A.

Cam Casting.

See Milling Machines, under MACHINE WORKS AND FOUNDRIES.

Case Hardening.

Modern Methods of Case Hardening. J. F. Springer. An illustrated article describing processes used and their defects, and the advantages of a new process of applying hydrocarbon gases for case-hardening steel, which has been invented by Adolph W. Machlet. 2000 w. Cassier's Mag—June, 1908. No. 93002 B.

Annealing Steel Castings. W. M. Carr. Read at meeting of Am. Found. Assn. Considers an annealed casting less liable to fail in service, and discusses conditions. 900 w. Ir Age—June 11, 1908. No. 92896.

Castings.

Method of Obtaining a Circular and Uniform Chill in Rolls. Thomas D. West.

We supply copies of these articles. See page 823.

Read before the Am. Soc, for Test. Mat. Illustrates and describes the invention of Ralph H. West, designed to overcome the evil effects of a contracting crust, giving a detailed account of the operation. 1400 w. Ir Age—June 25, 1908. No. 93300.

Chain Making.

The New Works of Messrs. Hans Renold, Limited. Illustrated description of these chain-making works, describing the chains made, and the extensive use of chain-driving, giving examples of the applications. 4500 w. Engng—May 22, 1908. Serial. 1st part. No. 92750 A.

Core Boxes.

Making Core Boxes by Machinery. A machine which handles a large variety of shapes and sizes is illustrated and described. 1000 w. Am Mach—Vol. 31, No. 26. No. 93306.

Cupolas.

Cupola Construction. Walter J. May. Drawings and description of a cupola of simple form. 1500 w. Mech Wld—June 5, 1908. No. 92963 A.

Cutting Tools.

Possibilities of High Speed Tool Steel. L. R. Pomeroy. A review of recorded tests, horse power requirements, etc., giving data on high-speed steel performances of much interest. General discussion. 11000 w. Pro Cent Ry Club—May 8, 1908. No. 93019 C.

Dies.

An Index Die for Armature Punchings. K. S. Allen. Diagram and description of an index die used for slotting armature punchings. 2000 w. Am Mach—Vol. 31, No. 25. No. 93036.

Drilling Machines.

Advanced Designs of German Drilling Machines. Oskar Kylin. Half-tones and description of types made in Dresden. 1200 w. Mach, N Y—June, 1908. No. 92696 C.

Foundries.

Problems Involved in the Erection and Equipment of a Modern Foundry. W. T. Hatch. Read before the New England Found, Assn. Describes features of the foundry of the Brown & Sharpe Mfg. Co. 3000 w. Foundry—June, 1908. No. 92718.

Foundry Materials.

Grading Pig Iron, Ferro-Alloys and Coke. Gives grading prepared by Eliot A. Kebler. 4000 w. Ir Trd Rev—June 25, 1908. No. 93321.

The Selection and Testing of Foundry Irons. F. M. Thomas. Read before the British Found. Assn. Gives a classification and discusses the effect of different elements. 2000 w. Mech Wld—June 5, 1908. Serial. 1st part. No. 92964 A.

The Selection and Testing of Foundry Irons. F. M. Thomas. Read at meeting at the Birmingham, Eng., Tech. Sch. Considers the selection, classification, refining, local characteristics, effects of various elements, etc. 6000 w. Mech Engr—May 22, 1908. No. 92744 A.

Foundry Practice.

Semi-Steel Mixtures and Methods of Calculating the Charges. M. B. Smith. 1500 w. Foundry—June, 1908. No. 92715.

Latter-Day Radiator Practice. Illustrates and describes interesting features of coremaking and molding as practiced in a Toronto shop. 1800 w. Foundry—June, 1908. No. 92712.

Automobile Cylinder Manufacture. L. N. Perrault. Read before the Am. Found. Assn. Discusses the process, its complications and requirements, etc. 2500 w. Ir Age—June 18, 1908. No. 93031.

Galvanizing.

The Deposition of Zinc for the Protection of Iron and Steel Surfaces. Sherard Cowper-Coles. Abstract of paper read before the Glasgow Tech. College Sci. Soc. Describes the processes at present in use for applying zinc to iron and steel, explaining the advantages of Sherardizing, etc. Ills. 6200 w. Ir & Coal Trds Rev—May 15, 1908. No. 92761 A.

Gear-Cutting.

The Pedersen Gear-Cutter. Illustrated description of an ingenious machine of unusual type, manufactured by Messrs. Vickers Sons & Maxim, Ltd., Erith, Eng. 1500 w. Engng—June 5, 1908. No. 92984 A.

A Worm Wheel Hobbing Machine. W. F. Groene. Illustrates and describes the machine used by the R. K. Le Blond Co. for hobbing index wheels and the accurate results. 1000 w. Am Mach—Vol. 31, No. 24. No. 92898.

Lathes.

A Heavy Locomotive Wheel Lathe. A 90-inch driving-wheel lathe, built by the Sellers Co., Philadelphia, is illustrated and described. 1000 w. Am Mach—Vol. 31, No. 23. No. 92768.

Machine Tools.

Machine Tools at the Franco-British Exhibition. Joseph Horner. Deals principally with the English exhibits, giving illustrated descriptions. Plates. 5000 w. Engng—June 5, 1908. No. 92983 A.

Milling Machines.

Alignment Tests of Le Blond Milling Machines. Illustrated description of tests regularly made and of manner of supporting the machine column. 1300 w. Mach, N Y—June, 1908. No. 92693 C.

A Machine for Milling Screw-Machine Cams. J. P. Brophy. A miller with geared mechanism and positive control is

We supply copies of these articles. See page 823.

illustrated and described. 1000 w. Am Mach—Vol. 31, No. 24. No. 92900.

Molding.

Molding a Steam Crane Cylinder. Joseph Horner. Illustrated description of a method of making a difficult casting. 1000 w. Foundry—June, 1908. No. 92716.

Molding Machines.

Spacing and Mounting Patterns. Alexander M. Thompson. Illustrates and describes a device for fitting patterns quickly and accurately on molding machines. 2000 w. Foundry—June, 1908. No. 92717.

Moulding and the Bonvillain and Ronceray Machines (Das Formverfahren und die Maschinen Patent Bonvillian & Ronceray). A. F. Hager. Discusses moulding machines in general and particularly the product of the machines mentioned. Ills. 2300 w. Oest Zeitschr f Berg u Hüttenwesen—May 23, 1908. No. 93148 D.

Patterns.

The Marking and Storing of Patterns. John J Jackson. Describes a system recommended. 2200 w. Mech Wld—June 5, 1908. No. 92962 A.

The Classification of Patterns. Oscar E. Perrigo. Explains a modern system of recording patterns. 3500 w. Foundry—June, 1908. No. 92714.

Errors in the Design of Patterns. Paul R. Ramp. Discusses changes that would overcome many difficulties. Ills. 2000 w. Foundry—June, 1908. No. 92713.

Pipe Founding.

Casting Pipes in Permanent Molds. Edgar A. Custer. Describes a method in which the supposed evils of unequal heating and cooling do not exist. Ills. 3500 w. Jour Fr Inst—June, 1908. No. 93259 D.

Planers.

A Rotary Twin Planer and Its Work. Claude Aikens. Illustrated description of a machine for the new works of the Allis-Chalmers Co., explaining its advantages. 1500 w. Am Mach—Vol. 31, No. 26. No. 93305.

Notes on the Design of a 36 x 36-Inch Planer. Gives the general features of the design, the elements determined by computation, and others decided upon by judgment. 5500 w. Am Mach—Vol. 31, No. 23. No. 92770.

Pneumatic Fixtures.

Pneumatic Fixtures for Holding Work. M. E. Service. Describes the application of compressed air for holding various kinds of work to be machined and its effect on the cost of production. Ills. 3500 w. Am Mach—Vol. 31, No. 23. No. 92769.

Screw Machinery.

Making Watch Parts in the Commercial Automatic Screw Machine. Illustrated description of American watchmaking practices. 2500 w. Mach, N Y—June, 1908. No. 92694 C.

Shop Appliances.

A Machine Shop Square That Is a Square. John E. Sweet. Illustrated description, with statement of its advantages and uses. 700 w. Am Mach—Vol. 31, No. 25. No. 93033.

Shop Heating.

Heating Systems for Mills. A. G. Hosmer. Address before the Nat. Assn. of Cotton Mfrs. Considers the merits and demerits of the various systems used. 3000 w. Heat & Vent Mag—June, 1908. No. 93028.

Shop Practice.

The Product and Methods of European Locomotive Works. Charles R. King. This second article of a series gives time and cost data of the new welding process. 2500 w. Engineering Magazine—July, 1908. No. 93394 B.

Building the Lucas Boring Machine. Illustrates and describes interesting details of shop construction and methods used in securing accurate work. 1800 w. Am Mach—Vol. 31, No. 26. No. 93304.

Machine Work on Steel-Mill Machinery. Information from a Pittsburg plant as to time consumed in roll turning, use of milling cutters for machining bearings, and other methods of work. Ills. 1600 w. Am Mach—Vol. 31, No. 92897.

Hand Turning Operations in the Lathe. James Lomas. Illustrates and describes methods used in machining pulleys, facing gear rims and hubs and performing numerous other operations in the hand lathe with simple tools. 2200 w. Am Mach—Vol. 31, No. 25. No. 93035.

Shops.

A Modern Wood Working Machinery Factory. H. R. Cobleigh. Illustrated detailed description of the Rochester works of the American Wood Working Machinery Co. 5500 w. Ir Age—June 18, 1908. No. 93030.

The Famout Creusot Works of France. J. B. Van Brussel. Illustrated description of this important metal-working plant. 1600 w. Am Mach—Vol. 31, No. 23. No. 92767.

The Adams Manufacturing Company's Works, Bedford. Illustrated description of works where starting switches and speed-regulating rheostats are made. 1500 w. Elec Engr, Lond—May 29, 1908. No. 92863 A.

The Edgwick Works of Messrs. Alfred Herbert, Ltd., Coventry. Brief illustrated description of the new machine tool works. Plates. 4500 w. Engng—June 12, 1908. No. 93225 A.

We supply copies of these articles. See page 823.

See also Chain Making, under MACHINE WORKS AND FOUNDRIES.

Shop Ventilation.

The Removal of Dust and Fumes in Factories. J. S. Haldane. The 4th Shaw lecture on "Industrial Hygiene." On the dangers of dust, gases, etc., methods of preventing or removing, and apparatus employed. Ills. 5500 w. Jour Soc of Arts —May 22, 1908. No. 92735 A.

Stores Departments.

The Arrangement and Management of the Stores Department at Opladen (Innere Einrichtung und Betrieb des Werkstätten-Hauptmagazins Opladen). Herr Schwarzer. Illustrated description of stores-keeping methods at these large repair shops of the Prussian State Railways. 5500 w. Glasers Ann—May 15, 1908. No. 93166 D.

Tool Systems.

See also Management, under RAILWAY ENGINEERING, MISCELLANY.

Welding.

Electric Welding and Some of Its Products. Illustrated description of the plant and products of the Electric Welding Products Company, Cleveland, Ohio. 1100 w. Ir Age—June 4, 1908. No. 92722.

Autogenous Welding of Metals. L. L. Bernier. Discusses high temperatures for industrial purposes obtained by means of oxyhydric, oxy-acetylenic, and oxygen burners. Ills. 3000 w. Boiler Maker—June, 1908. No. 93007.

Autogenous Welding in Auto Construction. E. S. Foljambe. Describes methods of work, and operations to which it is adapted. 2500 w. Automobile—June 25, 1908. No. 93352.

The Autogenous Soldering of Aluminium in Aeronautic Construction. Remarks on the uses of aluminium and the problem of soldering or welding and its solution. 1000 w. Sci Am—June 20, 1908. No. 93048.

New Processes for Metal Cutting and Autogenous Welding. J. B. Van Brussel. An illustrated article dealing especially with blow-pipe processes, giving practical results. 3500 w. Engineering Magazine—July, 1908. No. 93397 B.

See also Shop Practice, under MACHINE WORKS AND FOUNDRIES; and Track Bonding, under STREET AND ELECTRIC RAILWAYS.

MATERIALS OF CONSTRUCTION.

Alloys.

White Alloys: White Brass, White Bronze, etc. Walter J. May. Shows that some of the alloys claimed as new are only old alloys with new names. 1400 w. Prac Engr—May 22, 1908. No. 92742 A.

The Smelting of White-Metal Drosses and Residue and the Manufacture of Solder and Babbitt-Metals. Lionel D. Waixel. Illustrates and describes methods used at the plant of the Union Smelting & Refining Co., New York City. 1000 w. Brass Wld—June, 1908. No. 93052.

New Bronzes for Machine, Gun, and Ship Construction (Neue Bronzen für den Maschinen-, Geschütz-, und Schiffsbau). Walter Rübel. Discusses the properties of the "Rübel" bronzes recently put on the market by the Skoda Works, Pilsen. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver —May 29, 1908. No. 93163 D.

Alloy Steels.

Vanadium and Its Application to Steel-Making. Information concerning this metal, giving tabulated results of tests of vanadium steels, etc. 2000 w. Ir & Coal Trds Rev—May 29, 1908. No. 92885 A.

Vanadium Steels (Lettre de M. Rey-Maréchal, à propos des Aciers au Vanadium). A letter from M. Rey-Maréchal with notes by M. Léon Guillet. 2200 w. Rev de Métal—May, 1908. No. 93113 E + F.

Cast Iron.

Titanium in Cast Iron. Dr. Richard Moldenke. Read before the Am. Found. Assn. How to use ferro-titanium, the effect, remelting, etc. 2000 w. Ir Age—June 18. 1908. No. 93032.

Cast Iron in the Construction of Chemical Plant. F. J. R. Carulla. Read before the Iron & Steel Inst. Discusses the questions of the effect of acids and other chemicals and the precautions necessary to meet special conditions. 1800 w. Ir & Coal Trds Rev—May 15, 1908. No. 92757 A.

See also Metallography, under MATERIALS OF CONSTRUCTION.

Inspection.

Testing Is Not Inspection. W. A. Aiken. Read at meeting of the Am. Soc. for Test. Mat. Discusses commercial inspection methods. 2000 w. Ry & Engng Rev—June 27, 1908. No. 93410.

Irons.

Different Forms of Iron in Commerce. Henry Koehler. Brief consideration of pig-iron, cast-iron, steel, and wrought iron. 2500 w. Pro St Louis Ry Club—May 8, 1908. No. 93018.

Metallography.

The Metallography of Cast Iron (La Métallographie de la Fonte). Gives the results of researches on the effects of silicon. Ills. 2700 w. Génie Civil—May 16, 1908. No. 93129 D.

Nickel and Manganese in Cast Iron (Les Fontes au Nickel et les Fontes au Manganese). Léon Guillet. A metallographic study. 4000 w. Rev de Métal—May, 1908. No. 93114 E + F.

We supply copies of these articles. See page 823.

Semi-Steel.

See Foundry Practice, under MACHINE WORKS AND FOUNDRIES.

Steel.

Physical Qualities of Steel in Relation to Its Mechanical Treatment. James E. York. Read before the Ir. & St. Inst. Reviews the present methods of treatment, suggesting changes believed to result in more reliable rails and sections. 3300 w. Mech Engr—May 22, 1908. No. 92745 A.

Tool Steels.

See Cutting Tools, under MACHINE WORKS AND FOUNDRIES.

MEASUREMENT.

Hardness.

The Application of the Brinell Method to Special Steels (Application de l'Essai de Brinell aux Aciers spéciaux). M. Louis Revillon. Discusses especially the testing of small pieces. Ills. 2000 w. Rev de Métal—May, 1908. No. 93117 E + F.

Metric System.

The Engineering Pros and Cons of the Metric System. Arthur H. Allen. Outlines the origin and nature of the system, discussing its merits and defects. 5400 w. Soc of Engrs—June 1, 1908. No. 93020 N.

Pyrometry.

The Pyrometric Installation in the Gun Section, Royal Gun and Carriage Factories, Woolwich. Wesley J. Lambert. An illustrated description of the leading points of the system employed. 5500 w. Ir & Coal Trds Rev—May 15, 1908. No. 92760 A.

The Use of the Differential Galvanometer (Notes sur l'Emploi du Galvanomètre différentiel). M. A. Portevin. A mathematical discussion of its use in studying the heat treatment of steel. Ills. 3000 w. Rev de Métal—May, 1908. No. 93115 E + F.

Testing Methods.

A New Fatigue Test for Iron and Steel. T. E. Stanton. Read before the Iron & Steel Inst. An illustrated account of experimental investigations, describing the apparatus used. 1200 w. Engng—May 22, 1908. No. 92753 A.

Torsion Meters.

The Measurement of Mechanical Power by Torsion Meters (Emploi des Torsion-Mètres pour la Mesure des Puissances mécaniques). J. Izart. Illustrates and describes various types and their use. 4000 w. L'Elecn—May 16, 1908. No. 93-111 D.

See also Torque, under MARINE AND NAVAL ENGINEERING.

POWER AND TRANSMISSION.

Air Compression.

Imperfect Intercooling and Efficiency of Compression. S. B. Redfield. The article is confined to compound or two stage compression, and presents diagrams and curves showing the results. 2500 w. Compressed Air—June, 1908. No. 93025.

Belt Driving.

A Chart for Belt Horsepower, Area of Cut and Weight of Metal Removed. J. J. Densman. Gives a chart for determining the power developed by any pulley, having given the diameter, width, and speed. 400 w. Am Mach—Vol. 31, No. 26. No. 93303.

Chain Driving.

See Chain Making, under MACHINE WORKS AND FOUNDRIES.

Compressed Air.

Compressed Air Calculations. E. A. Rix. Read before the Min. Assn. of the Univ. of California. An explanation of methods of determining the amount of compressed air required for various kinds of work, and related matters. 3500 w. Compressed Air—June, 1908. No. 93026.

The Moisture in the Atmosphere and Its Effect on the Operation of Compressed Air Machinery, Especially Air Brake, Multiple-Unit Train Control and Train Signal Systems. H. M. Provost Murphy. Points out the physical laws involved, explaining the most approved methods of securing "dry air," etc. 4000 w. Eng News—June 18, 1908. No. 93042.

Costs.

The Cost of Steam Power in Varying Units. William O. Webber. A discussion of power costs as given in an earlier article by Mr. Snow. 1500 w. Engineering Magazine—July, 1908. No. 93399 B.

Electric Driving.

The Electrical Equipment of the Cargo Fleet Iron Co.'s Works. An illustrated description of an up-to-date installation. 5000 w. Ir Trd Rev—June 4, 1908. No. 92786.

An Electrically Driven Woodworking Plant. Illustrated description of a new plant at Marion, Va. 1500 w. Wood Craft—June, 1908. No. 92719.

Power Transmission in Woodworking Plants. W. L. Crouch. Gives conclusions from recent experience in a good-sized woodworking shop. Ills. 1500 w. Wood Craft—June, 1908. No. 92720.

Electric Power Transmission. Ira J. Owen. Presents the advantages of the system, urging its use in shops and discusses the fire hazard. Ills. 1800 w. Ins Engng—June, 1908. No. 93362 C.

Electric Driving for Machine Shops, Railroad Shops and Manufacturing Plants Using Machine Tools and Woodworking Machinery. Norman G. Meade. A discussion of the engineering features of motor driving. 2000 w. Elec Wld—June 6, 1908. No. 92777.

We supply copies of these articles. See page 823.

Electric Driving in Cotton-Spinning Factories. William Hanna. Discusses the advantages and the outlook for the application in England. 2000 w. Elec Engr, Lond—May 29, 1908. No. 92862 A.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

London.

Power Used in London Factories. T. H. Minshall. Gives statistics recently collected, with general remarks. 1500 w. Engng—May 29, 1908. No. 92872 A.

Mechanical Plants.

Plant of the Onondaga County Court House. Leo L. Post. Illustrated description of the plant and equipment. 2000 w. Power—June 9, 1908. No. 92901.

Mechanical Equipment of the Union National Bank Building, Pittsburg, Pa. Illustrated description of a very complete plant for a 21-story building. 2700 w. Eng Rec—June 27, 1908. Serial, 1st part. No. 93351.

Engineering of the Mechanical Equipment of a Large Store Building. Percival R. Moses. Describes the building and its equipment, discussing the different types of apparatus and systems of heating, lighting, power supply, ventilation, etc. Ills. 2500 w. Elec Rev, N Y—June 20, 1908. Serial, 1st part. No. 93082.

See also Central Plants, under HEATING AND COOLING.

Power Plants.

Internal Combustion Engines and Hydroelectric Power. Henry Docker Jackson. Outlines the possibilities of gasolene, gas and oil engines. 2000 w. Power—June 23, 1908. No. 93094.

Working Results from Gas-Electric Power Plant. J. R. Bibbins. Report of 30-day test on service plant, Richmond Works of the American Locomotive Co., Richmond, Va. 2500 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93296 D.

Power-House Equipment of the Fairfield Shipbuilding and Engineering Company, Ltd. Illustrated description of an exceptionally large private plant at Govan, Glasgow. 1000 w. Engng—June 12, 1908. No. 93226 A.

Messrs. Harland and Wolff's Works at Belfast. Illustrated description of the new power station and its equipment, and other improvements. 3000 w. Engng—June 12, 1908. No. 93228 A.

Identification of Power House Piping by Colors. William H. Bryan. Gives a tabulation of color schemes that have been tried, urging a uniform system. 2000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93252.

See also Coal Handling, under TRANSPORTING AND CONVEYING; and Trestles, under CIVIL ENGINEERING, BRIDGES.

Pulleys.

Methods and Means for Loosening Pulleys. Charles Herrman. Illustrates various methods. 1500 w. Power—June 23, 1908. No. 93097.

Rope Driving.

Rope Driving. W. H. Booth. Discusses briefly the velocity and stresses. 800 w. Power—June 16, 1908. No. 92995.

Sawmills.

Power Plants for Sawmills. W. J. Blackmur. Briefly discusses the advantages and disadvantages of steam, gas, and electricity as sources of power. 2000 w. Power—June 23, 1908. No. 93091.

Shafting.

Sizes of Shafts without Mathematics. John H. Barr. Gives chart for solving problems involved in designing or checking shafts having a solid, circular cross-section. 3000 w. Am Mach—Vol. 31, No. 24. No. 92899.

Textile Mills.

The Transmission of Power in the Textile Industry (Le Trasmissioni del Moto nell' Industria tessile). G. Beltrami. Discusses the relative merits of direct driving, gears, belts, ropes, and the electric drive. Serial, 1st part. 7000 w. L'Industria—May 10, 1908. No. 93-137 D.

STEAM ENGINEERING.

Boiler Management.

See Flue-Gas Analysis, under STEAM ENGINEERING.

Condensers.

Condensing Plant. W. Matthews. Brief consideration of various types of condensers. 1500 w. Mech Wld—June 19, 1908. No. 93412 A.

Air Leakage in Steam Condensers. Thomas C. McBride. A plea for scientific consideration of the subject. 3500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93255.

Cylinder Condensation.

Some Neglected Aspects of Cylinder Condensation. The first of a series of articles aiming to deal fully with this question. 3000 w. Engr, Lond—May 29, 1908. Serial, 1st part. No. 92877 A.

Ejectors.

New Ejectors. Diagrams and description of a new Westinghouse ejector of the self-starting type, which aims to maintain a higher vacuum than hitherto. 2000 w. Mech Engr—June 5, 1908. No. 92971 A.

Engine Design.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Economy.

See Engine Tests, and Piston Speed, under STEAM ENGINEERING.

We supply copies of these articles. See page 823.

Engine Governing.

Unequal Points of Cut-Off. W. H. Wakeman. Gives diagrams showing uneven points of cut-off, explaining the cause. 1000 w. Power—June 16, 1908. No. 92993.

Angular Variation Between a Shaft Governor and the Fly Wheel. Jacob H. Wallace. Presents a method for determining experimentally the angular variation between the arm of a governor carrying the eccentric and the fly wheel of the engine. 1000 w. Jour of Engng, Univ of Colo—No. 4. No. 93284 D.

Engines.

A Comparison Between Single and Double-Acting Engines. H. Keay Pratt. Discusses engines up to 50 or 60 B. H. P. 1800 w. Prac Engr—June 19, 1908. No. 93413 A.

Engine Tests.

Economy Tests of High Speed Engines. F. W. Dean. An account of tests to determine economy and efficiency of non-condensing reciprocating steam engines in actual operation. Ills. 4000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93256 C.

Entropy Diagram.

The Safe and Effective Use of the Entropy Diagram. S. A. Reeve. A discussion of the application of the entropy diagram to the solution of problems in engineering. 1500 w. Power—June 23, 1908. No. 93092.

Feed-Water Heating.

Steam Boiler Efficiency and Live Steam Feed-Water Heating. Albert Jonel. This first article of a series condemns the internal type of heater. 800 w. Elec Rev, Lond—June 19, 1908. Serial, 1st part. No. 93417 A.

Flue-Gas Analysis.

Does It Pay to Equip a Boiler Room with CO_2 Recorders? H. J. Westover. How to install the apparatus, the value of good records, how to read the chart, etc. 2000 w. Power—June, 1908. No. 92887.

Fuels.

Burning Oil for Power and Heating. William D. Ennis. Discussion of conditions under which best results are obtained, illustrating and describing types of equipment. 3500 w. Power—June 16, 1908. No. 92994.

Burning Oil for Power and Heating. William D. Ennis. A discussion of the properties and possibilities of fuel oil. 3000 w. Power—June 23, 1908. No. 93093.

Burning Liquid Fuel Without Steam or Compressed Air. Robert Schorr. Remarks on the Koerting system and its use with American oils. 1400 w. Min & Sci Pr—June 20, 1908. No. 93325.

Coal Briquettes and Their Use in Railroad, Marine and Domestic Service. F. R. Wadleigh. Reviews briefly the early use of briquettes, discussing the ends to be attained and the fuels used, methods, costs, etc. 2000 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93204.

Fuel Testing.

The Federal Fuel Testing Laboratory, Zurich. E. J. Constam. Illustrated description of this laboratory and the work carried on. 3000 w. Engr, Lond—June 12, 1908. No. 93232 A.

Piston Speed.

Piston Speed and Steam Engine Economy. R. L. Weighton. A report of a series of revolution trials with analysis of the results. 7 plates. Discussion. 5500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1908. No. 93271 N.

Plants.

Modern Steam Plants (Neuzeitliche Dampfanlagen). Chr. Eberle. Illustrates and describes plants in various industries embodying modern developments and improvements. 5000 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—May 2, 1908. No. 93180 D.

Pressure Gauges.

The Thermometer as a Steam Gage. William T. Heck. Describes the method. 500 w. Power—June, 1908. No. 92893.

Steam Jackets.

Steam Jackets. William Matthews. Discusses the results published by the Steam Engine Research Committee, and the experimental researches of Dr. Mellanby. 1600 w. Prac Engr—June 5, 1908. No. 92969 A.

Steam Pipes.

Expansion and Contraction in Steam Pipes. William F. Fischer. Exposition of the calculation involved, in laying out a system of steam piping, to insure flexibility. Ills. 2000 w. Power—June 2, 1908. No. 92701.

Steam Properties.

The Properties of Steam. Describes Juhlin's apparatus and experiments on the pressure of saturated steam at low temperatures. 4500 w. Locomotive—April, 1908. No. 92654.

Steam Traps.

Some Steam Traps. Gordon Stewart. Illustrates and describes recent designs. 2000 w. Prac Engr—June 12, 1908. Serial, 1st part. No. 93217 A.

Thermodynamics.

Throttling as Related to Knoblauch-Jakob Tests. A discussion of Prof. Heck's article by Prof. S. A. E. Reeve and Dr. Harvey N. Davis. 2400 w. Power—June 2, 1908. No. 92702.

Throttling.

See Thermodynamics, under STEAM ENGINEERING.

We supply copies of these articles. See page 823.

Turbine Plants.

A Simple Turbine Plant in New England. Illustrates and describes an interesting installation at Nashua, N. H., in which the turbines are about the only apparatus to be seen in the engine room. 500 w. Power—June 23, 1908. No. 93090.

Double-Deck Steam Turbine Power Plants. J. R. Bibbins. Presents some of the engineering features of this new type of station which the author believes, deserve careful consideration and ultimate acceptance as standard. Ills. 5000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93295 D.

Turbines.

Steam Turbines. J. N. Bailey. Explains the action of steam flowing through a turbine, and discusses the means of securing highest efficiency, design, etc. Ills. 3300 w. Elec Jour—June, 1908. No. 93013.

Test of a 200-Kilowatt Melms-Pfenninger Turbine. Report of test made by Prof. Schröter. 800 w. Engng—June 5, 1908. No. 92987 A.

The Westinghouse Double Flow Turbine. Illustrated detailed description of this self-balancing unit, especially adapted for large capacities. 2500 w. Power—June 16, 1908. No. 92992.

The New Double-Flow Turbines at the Brunot Island Power Plant, Pittsburg, Pa. Illustrates and describes these 5000-kw. turbines. 4000 w. Eng Rec—May 30, 1908. No. 92665.

12,000-Horse-Power Parsons-Type Steam-Turbine for the Electric Station, Buenos Ayres. Illustrated detailed description. 3200 w. Engng—May 22, 1908. No. 92751 A.

12,000 Horse-Power Steam-Turbine. Plate and description of the Parsons turbine for Buenos Ayres. 4000 w. Engr, Lond—May 22, 1908. No. 92755 A.

The 12,000 Horse Power Steam Turbine Built by the Firm of Franco Tosi, Legnano (La Turbina a Vapore di 12,000 H.P. construtta della Ditta Franco Tosi di Legnano). Illustrated description of this Parsons type turbine. 4800 w. L'Industria—May 10, 1908. No. 93136 D.

The Augsburg-Nürnberg Steam Turbine (La Turbina a Vapore della Maschinenfabrik Augsburg-Nürnberg). Illustrated description of this turbine of the Zoelly type. Serial, 1st part. 1500 w. L'Industria—May 17, 1908. No. 93138 D.

Some Aspects of Steam Turbine Engineering. H. Holzwarth. Deals principally with the difficulties in steam turbine engineering,—critical speed, effect of water carried in steam, ball bearings, etc. Ills. 2500 w. Wis Engr—June, 1908. No. 93233 D.

The Derivation of the Principal Turbine Equation by Means of Vectors (Die Ableitung der Turbinenhauptgleichung mit Hilfe der Vektorenrechnung). Viktor Fischer. A mathematical discussion. Ills. 2000 w. Zeitschr d Oest Ing u Arch Ver—May 15, 1908. No. 93161 D.

Valves.

Use of Weightless Back Pressure Valves. W. H. Wakeman. Illustrates and describes several types, discussing the effect of back pressure on the piston, etc. 3500 w. Power—June 9, 1908. No. 92902.

TRANSPORTING AND CONVEYING.

Cableways.

Ropeway at a Spanish Mine. Illustrated description of a Roe endless-rope ropeway at work at the Asturiana mines in Spain. 900 w. Engr, Lond—May 22, 1908. No. 92756 A.

Coal Handling.

Three Tramway Bridges on the Coal-Storage Dock of the Berwind-White Coal Mining Co., Superior, Wis. An illustrated description of this coal dock and its equipment for handling coal without breakage. 2000 w. Eng News—June 18, 1908. No. 93040.

Engineering Practice as Applied to the Fueling Equipment of Power Houses. Harry P. Cochrane. Illustrates and describes various devices for the mechanical handling of fuel, discussing factors justifying their installation. 3000 w. Jour Fr Inst—June, 1908. No. 93258 D.

See also Ore Handling, under TRANSPORTING AND CONVEYING; and Piers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Conveyors.

Conveying Machinery in the Portland Cement Plant. C. J. Tomlinson. Concerning types that are being tested and the results. 1200 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93251.

Continuous Conveying of Materials. Staunton B. Peck. Illustrates and describes types of conveyors in general use which have proved efficient. 5500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93250 D.

The Belt Conveyor. C. Kemble Baldwin. Illustrated description of belt conveyors, showing the development and types, the driving machinery, discharging devices, etc. 5500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93249 C.

Elevators.

A Curious Electric Elevator. J. B. Van Brussel. Illustrates and describes a novel elevator recently installed at St. Moritz in Switzerland, for conveying passengers to a hotel built on a hillside. 500 w. Sci Am—June 27, 1908. No. 93316.

We supply copies of these articles. See page 823.

Material Handling.

Transportation in Steel Works (Neuere Gesichtspunkte bei Hüttenwerkstransporten). C. Michenfelder. The first part of the serial discusses the handling of ore and fuel. Ills. Serial, 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 30, 1908. No. 93196 D.

Ore Handling.

Hoisting and Conveying Machinery. George E. Titcomb. Illustrates and describes types used in loading and unloading ores on the Great Lakes, handling coal, freight, etc. 3500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93248 D.

MISCELLANY.

Aeronautics.

Aeronautics. A. J. McKinney. A discussion of motor balloons and their propulsion, flying machines, etc. 2200 w. Autocar—May 23, 1908. Serial, 1st part. No. 92739 A.

Dirigible Balloons and Aeroplanes. William Duane. A brief sketch of important points in connection with navigation of the air. Ills. 1200 w. Jour of Engng, Univ of Colo—No. 4. No. 93279 D.

The Wright Aeroplane Test in North Carolina. Short illustrated account. 600 w. Sci Am—May 30, 1908. No. 92658.

Our Aeroplane Tests at Kitty Hawk. Orville and Wilbur Wright. An account of the recent experiments. 900 w. Sci Am—June 13, 1908. No. 92906.

First Flights of the Aerial Experiment Association's Second Aeroplane. Brief illustrated description of the machine and its trial. 900 w. Sci Am—May 30, 1908. No. 92657.

A Gigantic Airship Disaster. A critical account of the disaster in California to the John A. Morrell airship. 800 w. Sci Am—June 13, 1908. No. 92909.

See also Gasoline Engines, under COMBUSTION MOTORS.

Minting Machinery.

The Electrical Equipment of the Royal Mint, London. Illustrated description. 1500 w. Elect'n, Lond—June 12, 1908. No. 93221 A.

MINING AND METALLURGY

COAL AND COKE.

Brazil.

The Coal of Southern Brazil. Benedict Jose dos Santos. Information concerning the known deposits, the quality, etc. 1200 w. Min Jour—May 30, 1908. No. 92869 A.

Briquetting.

Binders for Coal Briquets. James E. Mills. A report of investigations made at the fuel-testing plant, St. Louis, Mo. 21300 w. U S Geol Surv—Bul. 343. (1908). No. 93010 N.

The Coal-Briquette Plant at Bankhead, Alberta, Canada. Edward W. Parker. Illustrated description. Discussion. 2800 w. Bul Am Inst of Min Engrs—May, 1908. No. 93266 C.

See also Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Coking By-Products.

By-Products from Coke Ovens. W. H. Coleman. Abstract of a paper before the Manchester Geol. & Min. Soc. Deals with sulphate of ammonia mainly, and its use in returning nitrogen to the soil. Also considers tar and benzol and their uses. 5000 w. Ir & Coal Trds Rev—May 29, 1908. No. 92884 A.

Coking Properties.

A Practical Test for Coking Coals. Max A. Pishel. A brief statement of the method of making an adherence test and the results obtained. Ills. Tabulated results. 2500 w. Ec-Geol—June, 1908. No. 93272 D.

Electric Power.

The Protection of Electric Motors and Apparatus Against Fire-Damp. Illustrates and describes a motor proof against fire-damp, following the principle of the Davy safety lamp. 1000 w. Elec Rev, Lond—June 5, 1908. No. 92972 A.

A Modern Electric Coal Mining Equipment. Frank C. Perkins. Brief illustrated description of a plant at Beth, W. Va. Coal is carried down a 1,300-ft. incline to the railroad. Electricity for power and light is furnished by a 110-kw. generator driven by belting from a high-speed engine. 1000 w. Min Wld—June 13, 1908. No. 92975.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. The third part of the serial describes the installations at the L'Espérance and Bonne-Fortune collieries at Montegnée lez-Liége and the Flémalle-Grande colliery at Ougrée-Marihaye. Ills. Serial, 3d part. 11500 w. Soc Belge d'Elecns—May, 1908. No. 93102 E.

England.

The Kent Coalfield. An account of the development of this new British coalfield. Ills. 3500 w. Min Jour—May 23, 1908. No. 92749 A.

We supply copies of these articles. See page 823.

Explosions.

Notes on the Monongah Explosion. James Ashworth. Ideas suggested by the lay-out of the mine and the methods of blasting. 2800 w. Mines & Min—June, 1908. No. 92707 C.

See also Mine Dust, under COAL AND COKE.

Formation.

Some Problems of the Formation of Coal. David White. Calls attention to the need of further field observation, and to recent progress. 10500 w. Ec-Geol—June, 1908. No. 93274 D.

Kentucky.

Mining Coal in Big Stone Gap Field, Kentucky. John P. Shippen. Describes methods of mining and coking used. Ills. 2000 w. Eng & Min Jour—June 27, 1908. No. 93358.

Mine Dust.

Investigation of Coal Dust as a Factor in Mine Explosions. Dr. Henry H. Payne. Read before the Coal Mining Inst. Brief review of various phases of coal dust investigation, and discussion of the methods of elimination. 7000 w. Ind Wld—June 29, 1908. No. 93408.

Mine Fires.

The Use of Carbon Dioxide in Extinguishing Mine Fires. Sydney F. Walker. Explains the methods of generating and using the gas, giving examples of the successful application. 3300 w. Mines & Min—June, 1908. No. 92705 C.

Mining.

Working a Coal Seam of Moderate Thickness. George Raylton Dixon. Describes a method of extracting pillars without causing crush and creep. 1200 w. Eng & Min Jour—June 20, 1908. No. 93070.

The Longwall Method of Working in England. George Raylton Dixon. Discusses the advantages of the system, details of operation and the plans for supporting the roof. 2500 w. Eng & Min Jour—June 6, 1908. No. 92823.

Special Methods of Mining Coal in England. George Raylton Dixon. Describes modifications of standard plans to suit special circumstances, giving details of an economical system of pony haulage. Ills. 1800 w. Eng & Min Jour—June 13, 1908. No. 92961.

New Mexico.

The Koehler Coal Mine. Frank A. Young. Illustrated description of this new mine in New Mexico, and its novel water supply. 2500 w. Mines & Min—June, 1908. No. 92708 C.

Nova Scotia.

Coal Mining in Pictou County, Nova Scotia. H. E. Coll. Explains conditions and the methods of safely mining gaseous and dusty mines. Ills. 1800 w. Eng & Min Jour—May 30, 1908. No. 92676.

Poland.

The Coal Mining Industry of Poland. John de Ciechanowski. Brief review of the history of the development of coal mining, and its present condition. 1500 w. Ir & Coal Trds Rev—May 22, 1908. No. 92763 A.

Rescue Appliances.

Rescue Appliances: Lessons from Glencoe. H. Kestner. A discussion of appliances and their use, with recommendations for rescue stations for coal mines in South Africa. 6000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92967 E.

How Rescue Work Can Be Carried On Effectively. W. E. Mingramm. The dangers of after-damp, rescue stations and their equipment, describing the Draeger apparatus. 2000 w. Min Wld—June 27, 1908. No. 93405.

Safety Lamps.

Tests of Benzin Safety Lamps with Special Reference to the Fillunger Igniting Apparatus (Ueber einige Durchschlagsversuche mit Benzin-Sicherheitslampen mit besonderer Berücksichtigung der Zündvorrichtung des k. k. Bergrates Dr. Fillunger). J. Mayer. Tests made of the liability of flame striking through the gauze. Serial, 1st part. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen—May 30, 1908. No. 93197 D.

Virginia.

The Boissevain Plant of the Pocahontas Consolidated Collieries Co., Inc. Illustrated description of the surface arrangements, methods of mining, transportation, etc. 3500 w. Mines & Min—June, 1908. No. 92703 C.

COPPER.

Alaska.

The Copper River District, Alaska. Hermann A. Keller. Illustrated account of the geology, mines and transportation facilities. Rich deposits of copper sulphide ores. 2000 w. Eng & Min Jour—June 27, 1908. No. 93355.

Anaconda.

Anaconda Copper Mining Company. A Review of the report of this company for the year ending Dec. 31, 1907. 2000 w. Eng & Min Jour—June 13, 1908. No. 92960

Assaying.

See Arsenic, under MINOR MINERALS.

California.

Copper Deposits in the Western Foot-Hills of the Sierra Nevada. William Forstner. A general description of the belt, with short description of some of the deposits. 5800 w. Min & Sci Pr—May 30, 1908. No. 92730.

We supply copies of these articles. See page 823.

Lake Superior.

Michigan Copper Mining Methods. Lee Fraser. Describes methods at various mines, especially at Tamarack, which is the deepest in the world. 2500 w. Min & Sci Pr—June 20, 1908. No. 93324.

Nevada.

Developments in the Ely District of Nevada. Leroy A. Palmer. An account of the copper mines opened at this old silver camp, with illustrated description of the works. 2800 w. Min Wld—June 20, 1908. No. 93074.

Refining.

The Electrolytic Copper-Refining Industry in 1907. John B. C. Kershaw. Information concerning the number of works using the electrolytic process, the new developments, etc. 1400 w. Elect'n, Lond—June 5, 1908. No. 92980 A.

Reverberatory Furnaces.

See Smelting, under COPPER.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, CONSTRUCTION.

Smelting.

Modern Reverberatory Smelting of Copper Ore. C. Offerhaus. Considers the application of the reverberatory furnace to the reduction of copper ores, giving an illustrated description of the latest furnace at Anaconda. 2500 w. Eng & Min Jour—June 13, 1908. Serial. 1st part. No. 92958.

United Kingdom.

Copper-Mining in the United Kingdom. Editorial review of this industry. 2200 w. Engng—June 5, 1908. No. 92986 A.

GOLD AND SILVER.

Assaying.

The Behavior of Tellurium in Assaying. Sydney W. Smith. An examination of the behavior of tellurium during pot fusion, scorification and cupellation. 4500 w. Inst of Min & Met, Bul No 44—May 14, 1908. No. 92915 N.

See also Cyaniding, under GOLD AND SILVER.

Australia.

See Kalgoorlie, under CIVIL ENGINEERING, WATER SUPPLY.

Cobalt.

Notes on Cobalt's Past, Present, and Future. Alex. Gray. Discusses the mining industry and the present conditions at Cobalt. Ills. 3000 w. Min Wld—June 6, 1908. Serial. 1st part. No. 92842.

Colorado.

Primary Gold in a Colorado Granite. John B. Hastings. Describes the geology, and the results of sampling, showing that the gold was not present in paying quantity. 2000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93263 C.

Cyaniding.

Laboratory Methods in Modern Cyanide Mills. Clyde H. Jay. Concerning the making up and standardizing solutions necessary in cyanide work. 2500 w. Min Wld—June 20, 1908. No. 93075.

Laboratory Methods Used in Modern Cyanide Mills. Clyde H. Jay. Concise statement of the methods used in cyaniding gold ores. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93277 D.

Cyanidation of Ores. Dr. Wilbur A. Hendryx. Read before the Colo. Sci. Soc. Deals with the mechanical handling of ores and the apparatus employed. 3500 w. Mines & Min—June, 1908. No. 92709 C.

Laboratory Tests on the Use of Coarse and Fine Lime for Cyaniding. W. J. Sharwood. An account of experiments made to ascertain the relative rapidity with which commercial lime would dissolve. 3000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92966 E.

Cyanidation in Nevada. A. G. Kirby. Editorial letter describing the treatment of the ore and discussing costs, concluding that Goldfield ore can be more economically reduced by the wet method than by roasting and cyaniding the crude ore. 4000 w. Min & Sci Pr—June 20, 1908. No. 93409.

Dredging.

Gold-Dredging Practice in California. Robert Sibley. An illustrated description of the construction of the hull of a dredge, the machinery, the designs most in favor and the methods of operation. 6000 w. Eng & Min Jour—May 30, 1908. No. 92671.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

History.

Gold Mining and the History of Civilization. F. Lynnwood Garrison. How the search for gold has extended civilization. 5500 w. Eng & Min Jour—May 30, 1908. No. 92674.

Mexico.

Ores and Mines of Santa Eulalia, Mexico. Claude T. Rice. Illustrated description of various silver-lead camps. 2500 w. Eng & Min Jour—June 27, 1908. No. 93357.

The Ore Deposits of Santa Eulalia, Mexico. Claude T. Rice. Outlines the history of this district, its ancient mines, and describes the geology, orebodies, manner of formation, etc. Ills. 2800 w. Eng & Min Jour—June 20, 1908. No. 93068.

Nevada.

Geologic Possibilities at Goldfield. Arnold Becker. Discusses especially the dacite of the Goldfield district. 800 w. Min & Sci Pr—June 20, 1908. No. 93323.

We supply copies of these articles. See page 823.

Round Mountain, Nevada. George A. Packard. Describes the geology and the gold ore deposits, and the mills. Ills. 2000 w. Min & Sci Pr—June 13, 1908. No. 93081.

Recent Work on the Comstock. Walter D. O'Brien. Information in regard to the new pumping plant, its cost, and what it has accomplished. Ills. 1200 w. Min & Sci Pr—June 13, 1908. No. 93080.

Quebec.

A Recent Discovery of Gold Near Lake Megantic, Quebec. Abstract of a report by John A. Dresser. Describes the district, geology, occurrence of ore deposits, etc. 2000 w. Can Min Jour—June 1, 1908. No. 92807.

Rand.

Present Mining Conditions on the Rand. Thomas H. Leggett. Discusses the development and future progress of the industry. Discussion. 6000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93261 C.

IRON AND STEEL.

Alabama.

The Brown Iron Ore Deposits of Alabama. William B. Phillips. The present article describes briefly the geological formations involved. Map. 3000 w. Ir Age—June 4, 1908. Serial. 1st part. No. 92726.

Assaying.

The Rapid Analysis of Pig and Cast Iron. Gives briefly method for the determination of the carbon, silicon, sulphur, phosphorus and manganese. 1500 w. Prac Engr—May 22, 1908. No. 92741 A.

The Gravimetric Determination of Phosphorus in Iron and Steel in the Form of Ammonium Phospho-Molybdate (Etude sur le Dosage ponderal du Phosphore dans les Fers, Fontes et Aciers sous Forme de Phosphomolybdate d'Ammoniaque). M. G. Chesneau. An account of extensive researches. 16000 w. Ills. Rev de Métal—May, 1908. No. 93-118 E + F.

See also Laboratories, under IRON AND STEEL.

Bessemer Process.

The Düdeling Modification of the Basic Bessemer Process (Das Düdelinger Verfahren zur Durchführung des Thomasprozesses). P. Goerens. A description of modifications in the Thomas process introduced by J. Flohr. 3200 w. Stahl u Eisen—May 13, 1908. No. 93142 D.

Blast-Furnace Charging.

New Blast-Furnace Charging Devices (Ueber neuere Hochofenbegichtungen). Illustrates and describes various types. 2400 w. Serial. 1st part. Stahl u Eisen—May 6, 1908. No. 93141 D.

Blast-Furnace Design.

The Design of the Iron Blast Furnace (Zur. Berechnung und Profilierung der Eisenhochöfen). Josef von Ehrenwerth. A review of general principles. Ills. 2800 w. Oest Zeitschr f Berg u Hüttenwesen—May 9, 1908. No. 93146 D.

Blast-Furnace Fuels.

Charcoal and Coke as Blast-Furnace Fuels. R. H. Sweetser. Gives data and results of furnace operations with both fuels at Sault Ste. Marie, comparing and discussing the advantages and disadvantages. 2500 w. Bul Am Inst of Min Engrs—May, 1908. No. 93262 C.

Blast Furnaces.

The Furnace Plant of the Northwestern Iron Co., Mayville, Wis. Illustrated description. 2000 w. Ir Trd Rev—June 25, 1908. No. 93318.

Blast-Furnace Slag.

Utilization of Blast Furnace Slag. Chevalier C. de Schwarz. Read before the I. and S. Inst. An illustrated review of methods of utilizing slag for the manufacture of bricks and cement. Ills. 3000 w. Ir & Coal Trds Rev—May 15, 1908. No. 92758 A.

Canada.

The Iron Ores of Canada. C. K. Leith. Compares certain general features of Canadian ores with types of deposits in the United States. 6000 w. Ec Geol—June, 1908. No. 93273 D.

Electro-Metallurgy.

Electric Smelting-Furnaces. B. Igewsky. Read before the Iron & Steel Inst. Illustrates and describes the construction of a new type of electric furnace for the smelting of iron and other uses. 2000 w. Engng—May 22, 1908. No. 92754 A.

Electric Iron and Steel Furnaces. Reviews electro-thermic iron-smelting during the last ten years, dealing only with processes actually in operation. Ills. 4700 w. Engng—June 5, 1908. Serial. 1st part. No. 92982 A.

The Electro-Metallurgy of Iron, Cast Iron and Steel in Mexico. Francis Louvrier. Shows how favorable are the conditions for electric furnaces, and the advantages over the blast furnace. 2000 w. Min Jour—May 30, 1908. No. 92868 A.

Electro-Metallurgy (L'Electrométallurgie). M. Matignon. A general review of recent progress in the electro-metallurgy of iron and steel. Ills. 9000 w. Bul Soc Int d'Elecns—May, 1908. No. 93103 F.

Casting Steel from the Electric Furnace (Stahlformguss aus dem elektrischen Ofen). Bernhard Osann. Describes the operation and results of Stassano's plant for the production of steel castings, at Bonn. Ills. 3500 w. Stahl u Eisen—May 6, 1908. No. 93140 D.

We supply copies of these articles. See page 823.

History.

Iron, from the Fifth to the Thirteenth Century (Das Eisenwesen vom 5 bis zum 13 Jahrhundert). Alfons Müllner. A historical review. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 16, 1908. No. 93147 D.

Laboratories.

The Metallurgical and Chemical Laboratories in the National Physical Laboratory. Walter Rosenhain. An illustrated account of this reorganized department and the work to be undertaken, especially researches on iron and steel assaying and metallurgy. Ills. 6000 w. Ir and Coal Trds Rev—May 15, 1908. No. 92759 A.

The Organization of the Modern Ironworks Laboratory (Zur Organisation moderner Eisenhüttenlaboratorien). A. Wencélius. Discusses the arrangement of the laboratory, the apparatus required, methods of work, etc. Ills. Serial. 1st part. 2000 w. Stahl u Eisen—May 13, 1908. No. 93143 D.

Lake Superior.

Diverting the Rivers at the Loretto Mine. Illustrated description of interesting work in this iron-mining district. 200 w. Ir Trd Rev—June 18, 1908. No. 93073.

The New Equipment at the Newport Mine. Illustrates and describes the new shaft house and its equipment and other features of the plant. 3500 w. Ir Trd Rev—June 18, 1908. No. 93072.

New York.

The Forest of Dean Iron Mine, New York. Guy C. Stoltz. An account of a deposit of magnetite within 50 miles of New York City, worked before the Revolutionary War, and still yielding commercial ore. 1200 w. Eng & Min Jour—May 30, 1908. No. 92673.

Open Hearth.

Recent Developments in Charging Machines. Illustrates and describes typical installations of the three general types of open-hearth furnace charging machines in use. 1800 w. Ir Trd Rev—June 25, 1908. No. 93319.

The Heating of Siemens-Martin Furnaces (Die Wärmetechnik des Siemens-Martinofens). F. Mayer. Gives the results of elaborate tests on the efficiency of the furnace under various conditions. Ills. Serial. 1st part. 5200 w. Stahl u Eisen—May 20, 1908. No. 93145 D.

Rolling Mills.

The Determination of the Sizes of Rolling-Mill Motors (Die Bestimmung der Grösse von Walzenzugmotoren). Th. Schmitt. Describes the determination of the power required and discusses the choice of a motor. Ills. 2500 w. Elek Kraft u Bahnen—May 23, 1908. No. 93177 D.

Segregation.

Piping and Segregation in Steel Ingots. A discussion of the paper of Prof. Howe. Ills. 10800 w. Bul Am Inst of Min Engrs—May, 1908. No. 93268 D.

Steel Making.

See Bessemer Process, and Electro-Metallurgy, under IRON AND STEEL.

Steel Works.

The Keystone Works of the Jones & Laughlin Steel Company. Illustrated detailed description of a new structural plant at Pittsburg, Pa. 2000 w. Ir Age—June 4, 1908. No. 92723.

A Structural Plant in the Philippines. Royal J. Mansfield. Illustrated description of the first structural steel works in the Philippines, and some of the structures built by it. 1000 w. Eng News—June 11, 1908. No. 92939.

See also Material Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

LEAD AND ZINC.

Colorado.

The Montezuma Mining District. Etienne A. Ritter. Gives the location of this lead and zinc district, describing the ores, methods of mining and transportation. Ills. 3000 w. Mines & Min—June, 1908. No. 92704 C.

Lead.

Notes on Lead. Prof. A. Humboldt Sexton. Deals with its physical and chemical properties, its oxides, lead minerals, ores and their distribution, in the present number. 3300 w. Mech Engr—May 22, 1908. Serial. 1st part. No. 92743 A.

Mexico.

See same title, under GOLD AND SILVER.

Missouri.

See Ore Deposits, under MISCELLANY.

Sardinia.

See Zinc Milling, under ORE DRESSING AND CONCENTRATION.

Tasmania.

Mining in Zeehan Silver-Lead Field, Tasmania. Ralph Stokes. Considers the geology of the deposits, and system of ore treatment, etc. Ills. 2500 w. Min Wld—June 6, 1908. No. 92845.

Zinc Production.

Production and Consumption of Zinc in 1907. Walter Renton Ingalls. Statistics of zinc ore production in the United States, Canada, and Mexico; and consumption according to uses. 3500 w. Eng & Min Jour—June 13, 1908. No. 92957.

MINOR MINERALS.

Antimony.

See Arsenic, under MINOR MINERALS.

Arsenic.

The Iodometric Determination of Ar-

We supply copies of these articles. See page 823.

senic and Antimony Associated with Copper. F. H. Heath. Describes the method used which gave results with errors of only a few tenths of a milligram. 1700 w. Am Jour of Sci—June, 1908. No. 93012 D.

Bauxite.

Bauxite: Its Occurrence and Production in U. S. W. C. Phalen. Information concerning the geology and development of the deposits. 2000 w. Min Wld—June 27, 1908. No. 93406.

Cement.

A 12,000-Barrel Cement Mill in California. Illustrated detailed description of the new mill at Davenport, Cal. 7000 w. Eng Rec—June 20, 1908. No. 93066.

An Iowa Portland Cement Plant. George M. Shepard. Illustrated description of the plant at Mason City, Iowa. 1700 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93391 N.

See also Blast-Furnace Slag, under IRON AND STEEL.

Gypsum.

Gypsum Deposits of Montana. J. P. Rowe. Brief description of the deposits and of the operations at Armington. 1000 w. Eng & Min Jour—June 20, 1908. No. 93069.

Lime.

The Determination of Lime in Limestone, etc. Richard K. Meade. Gives a comparison of various methods, describing method of precipitation in a solution of oxalic acid which gives results that check closely with a complete gravimetric analysis. 2000 w. Min Wld—June 13, 1908. No. 92976.

Manganese.

Mining and Preparation of Georgia Manganese. Thomas L. Watson. Gives the geology, mining methods, etc. Map. 1500 w. Min Wld—June 13, 1908. No. 92977.

Atopite and the Manganese Deposits of Miguel Burnier, Brazil. Dr. E. Hussak. Describes the deposits. 1000 w. Min Jour—May 30. 1908. No. 92870 A.

Mining in the Batoum District, Russia. From the report for 1907 of Mr. Consul Stevens. Concerning the manganese and petroleum industries. Map. 2800 w. Min Jour—May 30, 1908. No. 92867 A.

Natural Gas.

Natural Gas for Power Use in the Joplin District. Otto Ruhl. Information concerning the consumption and costs of natural gas piped from Kansas, and the advantages of gas fuel over coal. 2000 w. Min Wld—June 27, 1908. No. 93404.

Oil.

The Illusiveness of Petroleum. W. S. Eberman. Reviews briefly the early history of oil discovery in Pennsylvania, and also in other localities, and some points in regard to the geology. 1600 w. Min Wld—June 27, 1908. No. 93407.

See also Manganese, under MINOR MINERALS.

Talc.

Mining Talc in North Carolina. An illustrated account of the deposits, method of mining, finishing, etc. 2000 w. Ir Trd Rev—June 25, 1908. No. 93320.

Tin.

The Refining of Tin by Electricity (Die elektrische Raffination des Zinn). Dr. Otto Steiner. A description of the Strauss electrolytic method. Serial. 1st part. 1800 w. Elektrochem Zeitschr—May, 1908. No. 93139 D.

See also same title, under ORE DRESSING AND CONCENTRATION.

Vanadium.

Occurrence of Vanadium Near Telluride, Colorado. Edward R. Zalinski. Describes the deposits and the treatment of the ore. Ills. 1500 w. Eng & Min Jour—June 6, 1908. No. 92824.

See also Alloy Steels, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

MINING.

Blasting.

Group Electric Shot Firing. Sydney F. Walker. Discusses troubles with fuses and the remedy. 2500 w. Eng & Min Jour—June 20, 1908. No. 93071.

Bunk Houses.

New Type of Native Compound Building of All Metallic Construction. Diagrams and description of an economical building for housing native labor in South Africa. 1500 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92965 E.

Cableways.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Costs.

Costs and Profits in Silver-Lead Ore Production. James Ralph Finlay. Discusses factors governing costs, comparing conditions at several mines. 4000 w. Eng & Min Jour—June 27, 1908. No. 93356.

Drill Bits.

The Proper Shape of Rock Drill Bits. D. J. O'Rourke. Deals with the material used, and the shaping, sharpening, setting, etc. Ills. 2000 w. Engng-Con—June 24, 1908. No. 93330.

Electric Power.

Discussion on "The Electrical Equipment of Gold Mines." The paper of H. J. S. Heather is discussed. 14500 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92918 N.

We supply copies of these articles. See page 823.

Electric Power at the Clausthal Mines. Alfred Gradenwitz. An illustrated description of the equipment. Current from producer-gas engine and turbine plants drives the ore-dressing works during the day and the mine hoists at night. 2200 w. Eng & Min Jour—June 6, 1908. No. 92821.

Explosives.

A Magazine and Thaw-House for Dynamite. George F. Samuel. Gives a design, and results of tests made to determine the time required to thaw dynamite. 800 w. Eng News—June 25, 1908. No. 93337.

Finance.

Capitalizing and Promoting Mining Properties. W. A. Crooks. On the methods of organizing and financing a mine. 3200 w. Min Wld—June 6, 1908. No. 92843.

Hoisting Engines.

Winding Engine Tests, with Notes and Suggestions on the Design and Testing of Plant. S. L. Thacker. Abstract of paper before the Inst. of Min. Engrs. 4000 w. Mech Engr—June 19, 1908. No. 93416 A.

Law.

Discovery Before Location. R. W. Raymond. Brief discussion of laws in the United States having a bearing on the appropriation of mineral lands. 1000 w. Can Min Jour—June 15, 1908. No. 93086.

Mine Fires.

See same title, under COAL AND COKE.

Mine Waters.

Mine Waters: Their Composition and Value. Alfred C. Lane. The analysis of mine waters may help to locate ore deposits. Methods of testing and related information. 1100 w. Min Wld—June 6, 1908. No. 92841.

Prospecting.

Constructing a Crude Smelter for Prospectors. Francis C. Nicholas. Illustrated description of methods of smelting iron ore in a crude way on a newly discovered prospect. 2200 w. Min Wld—June 6, 1908. No. 92840.

Reports.

Current Monthly Reports of Mines. H. S. Denny. Suggestions for the arrangement of the information so that the facts may be easily compared and summarized. 4000 w. Eng & Min Jour—June 6, 1908. No. 92822.

Shaft Sinking.

Sinking a Concrete Mine Shaft. Illustrated description of work in progress near Wilkes-Barre, Pa. 1400 w. Sci Am Sup—June 13, 1908. No. 92911.

Methods of Shaft Sinking. Brief illustrated descriptions of the "Kind-Chaudron" boring process, the freezing process, sinking by means of drop shafts, and subaqueous sinking work by means of sackborers. 2500 w. Ir & Coal Trds Rev—May 22, 1908. No. 92762 A.

Unwatering.

Reclaiming a Flooded Gypsum Mine. E. H. Fishack. Describes the rather unusual method employed at a mine in Ohio, near Sandusky Bay. 1100 w. Eng & Min Jour—May 30, 1908. No. 92675.

ORE DRESSING AND CONCENTRATION.

Classifiers.

The Dorr Classifier. J. N. V. Dorr. Illustrates and describes an apparatus for separating slime from sands and also for removing a large part of the water. 1200 w. Mines & Min—June, 1908. No. 92711 C.

Crushers.

A Rock Crusher of 800 Tons per Hour Capacity. Richard Bernhard. Illustrated description of the largest stone crusher in existence, in operation at South Pittsburg, Tenn. 900 w. Eng News—June 4, 1908. No. 92847.

Gold Milling.

The Average Rate of Accumulation and Absorption of Gold Amalgam by Copper Plates. Edward Halse. Information on this subject, gathered by the writer. 2000 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92916 N.

The Absorption and Accumulation of Gold on Copper Plates. W. F. A. Thomae. Discusses the amount of gold locked-up on battery plates. 1400 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92917 N.

See also Nevada, under GOLD AND SILVER.

Jigs.

Jigs and Jigging in the Joplin Zinc-Lead District. Otto Ruhl. Describes the construction and operation of the hand jig, the Cooley jig, and the Faust automatic jig. Ills. 3500 w. Min Wld—May 30, 1908. No. 92677.

First Practical Application of the Forest Jig. Doss Brittain. Describes an innovation in the milling practice of the Joplin district. Ills. 700 w. Eng & Min Jour—May 30, 1908. No. 92672.

Lead Milling.

See Tasmania, under LEAD AND ZINC.

Magnetic Separation.

Dry, Magnetic, and Electro-Chemical Separation Processes. W. G. Swart. Brief discussion of each of these processes and their limitations. 2200 w. Min Jour—June 13, 1908. No. 93223 A.

See also Zinc Milling, under ORE DRESSING AND CONCENTRATION.

Mixed Sulphides.

Dressing Sulphide Ores. E. B. Wil-

son. On the importance of adapting the methods of treatment to the peculiarities of the ores. 1800 w. Mines & Min—June, 1908. No. 92706 C.

Tin.

The Final Stages of Tin and Wolfram Dressing. S. L. Terrell. Deals with tin and wolfram after concentration, considering fine and rough concentrates. 2000 w. Min Jour—June 13, 1908. No. 93224 A.

Tube Mills.

The Economics of Tube Milling. H. W. Fox. Gives experiments showing the relation between the amount of ore, pebbles, and solution, and the amount of power consumed. 3000 w. Mines & Min—June, 1908. No. 92710 C.

Zinc Milling.

The Mechanical Preparation of Ores in Sardinia. Erminio Ferraris. Describes the ore-dressing methods, concentration, magnetic separation, etc. Ills. 7200 w. Bul Am Inst of Min Engrs—May, 1908. No. 93267 D.

Economical Treatment of Zinc Ores. R. C. Canby. A brief review of various types of magnetic separators and their adjuncts and value. 1500 w. Min Wld—June 6, 1908. No. 92844.

See Jigs, under ORE DRESSING AND CONCENTRATION.

MISCELLANY.

Alloys.

The Alloys of Aluminium (Les Alliages d'Aluminium). M. A. Portevin. Information taken from *Zeit. an. Chemie*, on alloys of aluminium with bismuth, calcium, cadmium, cobalt, copper, iron, potassium, magnesium, sodium, nickel, lead, tin and thalium. Ills. 4200 w. Rev de Métal—May, 1908. No. 93-116 E + F.

British Columbia.

Mineral Production of British Columbia. Ernest Jacobs. Official returns, reporting a decrease in gold, silver and lead, but gains in coal and coke. 2500 w. Eng & Min Jour—June 27, 1908. No. 93359.

China.

Mineral Production of China in 1907. Thomas T. Read. Reports abundant resources of many kinds of ore, but slow development of the mineral industry. 3000 w. Eng & Min Jour—June 27, 1908. No. 93360.

Georgia.

Mining and Metallurgical Industry of Georgia. Henry A. Mather. Describes the geology of the Dahlsnega district, which yields gold, china clay, talc and rare ore deposits, but is neglected and thriftless. 1800 w. Min Wld—June 20, 1908. No. 93076.

Guatemala.

Mining and Transportation in Guatemala. Clarence C. Sample. Information of the railroads, mining and its development, etc. 2000 w. Eng & Min Jour—June 13, 1908. No. 92959.

Mexico.

Mexican Notes. Mark R. Lamb. Illustrated description of treatment-plants in Mexico. 1200 w. Min & Sci Pr—May 23, 1908. Serial, 1st part. No. 92729.

New Mexico.

Development of San Pedro Mountain, N. M. Robert B. Brinsmade. History of old Spanish mines which have produced gold, lead, copper and silver, now being worked by modern methods. Ills. 3500 w. Min Wld—June 27, 1908. No. 93403.

Ore Deposits.

Diffusion as a Factor in Ore Deposition. Lewis T. Wright. Discusses the flow of minerals by aqueous diffusion. 1800 w. Min & Sci Pr—June 20, 1908. No. 93323.

Waters, Meteoric and Magmatic. James F. Kemp. Considers the formation of ore bodies from solutions of underground waters. 3500 w. Min & Sci Pr—May 23, 1908. No. 92682.

Volcanic Waters. John B. Hastings. Discusses whether waters buried deeply with oceanic sediments can make their way to the conduits of molten material, quoting other investigators. 4000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93265 C.

Unconformity and Deposits. Otto Ruhl. Shows how the application of the theory that ore deposits are always accompanied by dynamic movements completely misconstrued the facts in ascribing an origin for the lead and zinc ore deposits of the Missouri-Kansas district. Ills. 1600 w. Min & Sci Pr—June 6, 1908. No. 92922.

Ore Volume.

The Relation of Density, Porosity, and Moisture to the Specific Volume of Ores. Warren J. Mead. Gives a diagram for determining the cubic contents of ores based on the relation of these factors, explaining its use. 2200 w. Ec-Geol—June, 1908. No. 93275 D.

Pegmatite.

Origin of Pegmatite. John B. Hastings. Gives information from various authorities concerning pegmatite, its microscopic features, and theories explanatory of its origin. 10000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93-264 C.

Sweden.

See same title, under INDUSTRIAL ECONOMY.

We supply copies of these articles. See page 823.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Communication.

Railway Telephony. W. E. Harkness. Read before the N. Y. Telephone Soc. An account of the service and the methods employed. 9000 w. Ry & Engng Rev—June 20, 1908. No. 93077.

New York Suburbs.

Improvement of New Jersey-New York Suburban Service. The first of a series of articles dealing particularly with the railroads in New Jersey which have their termini on the west shore of the Hudson River. The present article considers the Lackawanna Railroad. 1500 w. Sci Am—June 20, 1908. Serial, 1st part. No. 93047.

Signals.

The Electric Operation of Signals and Points at Schwerte Station. Mr. Schepp. Illustrated detailed description of the mechanism and its operation. 12000 w. Bul Int Ry Cong—June, 1908. Serial, 1st part. No. 93379 G.

The New Interlocking Signal System at the Broad Street Terminal, Philadelphia. Illustrated detailed description of the plant. 2500 w. Eng Rec—June 27, 1908. No. 93348.

The Electric Locking of the Westinghouse Signal and Switch Levers (Die elektrische Verkettung an den Westinghouseschen Signal- und Weichenstellhebeln). L. Kohlfürst. Illustrated description of the mechanism and electrical connections. Serial, 1st part. 2400 w. Schweiz Bau—May 23, 1908. No. 93151 D.

Electric Control for Block Signals (Elektrischer Antrieb für Eisenbahn-Mastsignale). L. Kohlfürst. A general description of signals recently installed on the Southern Railway of Austria. Ills. 3000 w. Elek Kraft u Bahnen—May 4, 1908. No. 93175 D.

See also Subway Signalling, under STREET AND ELECTRIC RAILWAYS.

Trains.

The Atlantic City Flyer. Describes the fast trains to this resort from Camden by the Philadelphia & Reading R. R. and the locomotives used. 1500 w. Ry & Loc Engng—June, 1908. No. 92787 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Westinghouse Brake Equipments. Describes various types. 2000 w. Ry & Loc Engng—June, 1908. No. 92791 C.

Brake Trials on the North-Eastern Railway. An account of an interesting series of tests made of the Maximus brake. 1200 w. Engr, Lond—June 5, 1908. No. 92991 A.

Brake Trials on Long Goods Trains, Made in June and July, 1907, on the Hungarian State Railway. Report of an interesting series of trials. 1700 w. 10 Tables. Bul Int Ry Cong—June, 1908. No. 93380 G.

An Early and Thorough Test of Continuous Brakes in England. C. H. Caruthers. A description of a thorough competitive test carried out between June 9 and 16, 1875, on a division of the Midland Ry. 1200 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93202.

Cable Railways.

A Remarkable Mountain Railway. Dr. Alfred Gradenwitz. Illustrations and brief description of a road at Bozen, Tyrol, with gradients of 70 per cent. in the upper half, and 66 per cent. in the lower. 800 w. Sci Am—June 20, 1908. No. 93050.

Car Design.

The Design of Sills (Calcul des Longerons armé). O. Lebeau. A mathematical paper, referring principally to the side pieces of railway cars. Ills. 2500 w. All Indus—May, 1908. No. 93123 D.

Car Oscillation.

The Oscillations in Cars at High Speed and Their Measurement (Theoretische Betrachtungen über die Schwingungen von schnellfahrenden D-Zugwagen und deren praktische Messung). Herr Mehlis. A theoretical and mathematical discussion of their production with practical data on methods of measurement. Ills. 7000 w. Glasers Ann—May 1, 1908. No. 93164 D.

Car Repairing.

See Management, under MISCELLANY.

Cars.

New Design Standard Steel Coach; Southern Pacific. Illustrated description. 700 w. R R Age Gaz—June 12, 1908. No. 92946.

Steel Passenger Cars. Abstract of a committee report presented at the convention of the Master Car Bldrs.' Assn. 2500 w. Elec Ry Jour—June 27, 1908. No. 93328.

Structural Steel in Freight Car Construction. G. A. Akerlind. An illustrated article describing the types of the National Dump Car Co., Chicago. 2000 w. Ry & Engng Rev—June 13, 1908. No. 92978.

Cars for the Virginia Coal Business.

We supply copies of these articles. See page 823.

Editorial, with illustrated detailed descriptions of cars on the Norfolk & Western, the Chesapeake & Ohio, and the Virginian Ry. 8500 w. R R Age Gaz—June 12, 1908. No. 92942.

Reinforcing Light Wooden Cars on the Santa Fe. Illustrates and describes the applications of a steel sub-frame. 900 w. R R Age Gaz—June 12, 1908. No. 92943.

First Class Dining-Car for the Lancashire and Yorkshire Railway Company. Plate, illustration, and short description. 600 w. Engng—May 29, 1908. No. 92876 A.

Electrification.

Electric Traction on the Bavarian State Railways. Reviews a recent report of the Bavarian Government dealing fully with questions bearing on this subject. 2500 w. Elect'n, Lond—May 29, 1908. No. 92865 A.

The Electrification of the Bavarian State Railways (Ueber die Einführung des elektrischen Betriebes auf den Bayerischen Staatseisenbahnen). W. Reichel. An elaborate and thorough discussion of the problem of applying electric traction to all the railways of the state. Ills. Serial, 2 parts. 13000 w. Elek Kraft u Bahnen—May 4 and 14, 1908. No. 93176, each D.

Locomotive Crank Axles.

The Solution of the Crank Axle Problem. Howard H. Lanning. Describes improvements made in the construction of crank axles, and the re-turning machines used. Ills. 3000 w. Am Engr & R R Jour—June, 1908. No. 92812 C.

Locomotive Flues.

A Reinforced Flue Sheet. W. H. Lewis. Explains the object of the reinforcing sheet as attached to the firebox flue sheet of locomotives, describing details. 1500 w. Am Engr & R R Jour—June, 1908. No. 92809 C.

Locomotive Fuels.

See Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Locomotive Repairs.

The Cost of Locomotive Repairs on the Atchison, Topeka & Santa Fe. Calls attention to conditions which have an influence on the cost of repairs. 2000 w. R R Age Gaz—June 19, 1908. No. 93203.

The Repair of Locomotive Tube Plates (La Réparation des Plaques tubulaires des Foyers de Locomotives). S. Ragno. A description of the author's method and its results. Ills. 7000 w. All Indus—May, 1908. No. 93122 D.

Locomotives.

Mikado for the Kentucky and Tennessee. Illustrated description. 700 w. Ry & Loc Engng—June, 1908. No. 92794 C.

Mikado Locomotive for the Kentucky and Tennessee Railway. Illustrated description. 600 w. Ry Age—May 29, 1908. No. 92685.

Heavy 4-6-2 for the N. Y. C. Illustrated description of the heaviest passenger locomotives ever built for this road. 500 w. Ry & Loc Engng—June, 1908. No. 92788 C.

Denmead Ten-Wheel Freight Engine. J. Snowden Bell. Illustrated description of an engine probably built in the late fifties, showing the standard practice of that time. 500 w. R R Age Gaz—June 19, 1908. No. 93201.

Locomotives for Heavy Service on the Norfolk & Western. Illustrates and describes a Pacific (4-6-2) for passenger work, and a 12-wheeler (4-8-0) for freight. 400 w. R R Age Gaz—June 19, 1908. No. 93099.

Recent Narrow Gage Locomotives for Heavy Service. Illustrated descriptions of three recent types having a track gage of three feet. 1800 w. Ry & Engng Rev—June 20, 1908. No. 93078.

British Locomotives in 1907. Charles Rous-Marten. A review of progress made in design and performance. 6000 w. Bul Int Ry Cong—May, 1908. No. 93371 G.

The Locomotives of the Eastern Railway of France. Charles S. Lake. Begins an illustrated review of the successive developments in size and design on this important railway. 2500 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93205.

New Continental Locomotives. Illustrated descriptions of engines recently built for the Western Ry. of France, and for the Alsace-Lorraine Rys. 1500 w. Mech Engr—June 5, 1908. No. 92970 A.

Historic Locomotives at Purdue. Robert C. Schmid. Brief illustrated descriptions of types in the Purdue museum. 2500 w. Ry & Loc Engng—June, 1908. No. 92793 C.

Characteristics of Steam Locomotives. Edward P. Burch. Considers the characteristics of locomotives in common commercial service. 3500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93392 N.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives tables arranged with respect to classes and weights, and arranged in order of total weights. 2500 w. Am Engr & R R Jour—June, 1908. No. 92974 C.

Test of Mallet Articulated Compound Locomotive. An account of a recent test made on the Erie Railroad, giving results, and interesting features peculiar to this type. Ills. 3500 w. Am Engr & R R Jour—June, 1908. No. 92811 C.

We supply copies of these articles. See page 823.

Mikado Locomotive for the Virginian Railway. Illustrated description of a Mikado (2-8-2) locomotive for gathering and distributing cars and hauling to the Princeton yard. 3500 w. R R Age Gaz—July 3, 1908. No. 93506.

Locomotive Stoking.

Bank Firing of Bituminous Coal. R. G. Donaldson. Explains this method of firing, discussing its advantages and disadvantages. 1500 w. Ry & Loc Engng—June, 1908. No. 92790 C.

Locomotive Valve Gears.

Walschaert Valve Gear. Illustrates and describes a design that has been developed on the Pennsylvania R. R. for use on high speed Atlantic type locomotives. 700 w. Am Engr & R R Jour—July, 1908. No. 93509 C.

Steam vs. Electricity.

Steam and Electricity Compared. W. B. Kouwenhoven. Considers only the increasing schedule speed, showing the advantages of electricity. 2000 w. Ry & Loc Engng—June, 1908. No. 92792 C.

See also Operation, under STREET AND ELECTRIC RAILWAYS.

Wheels.

Car Wheels—Forged and Rolled—History Past and Present. An illustrated review of the development of car wheels. 4000 w. Ind Wld—June 8, 1908. No. 92833.

The Chilled Cast Iron Car Wheel. P. H. Griffin. A discussion of problems growing out of the present practice of makers and the railroads. 3000 w. Ir Age—June 4, 1908. No. 92727.

Cast Iron Car Wheels. P. H. Griffin. An editorial letter taking issue with conclusions drawn by J. E. Muhlfeld, in a recent communication. 5000 w. R R Age Gaz—June 26, 1908. No. 93331.

Cast Iron Wheels. J. E. Muhlfeld. A summary of conclusions in regard to improving the efficiency of the chilled cast iron wheel, with a general review of conditions, materials, etc. Diagrams. 9500 w. R R Age Gaz—June 12, 1908. No. 92944.

I. For Safe and Economic Car Wheels. Charles T. Schoen. II. Chilled Cast Iron Wheels. P. H. Griffin. Two editorial letters discussing means of producing better car wheels. 6500 w. R R Age Gaz—June 19, 1908. No. 93098.

NEW PROJECTS.

K. C., M. & O.

Progress of the Kansas City, Mexico & Orient. An account of the development of this line, the mining districts it will serve, and other information. Maps. 2500 w. Ry Age—May 29, 1908. No. 92684.

PERMANENT WAY AND BUILDINGS.

Ash Lifts.

Ash-Lifts. F. Zimmermann. Illustrates and describes mechanical methods of handling ashes at the locomotive sheds in Germany. 1300 w. Bul Int Ry Cong—May, 1908. No. 93372 G.

Coaling Plants.

Reinforced-Concrete Locomotive-Coaling Station on the Norfolk & Western Ry., at Concord, Va.: A Type of the Most Recent Equipment. Illustrated description. 500 w. Eng News—June 25, 1908. No. 93336.

Culverts.

See same title, under CIVIL ENGINEERING, BRIDGES.

Curves.

Resistance of Railway Cars on Curves (Widerstand der Eisenbahnfahrzeuge in Gleisbogen). Herr Dietz. A mathematical treatment. Ills. 3500 w. Glasers Ann—May 1, 1908. No. 93165 D.

Rails.

The Steel Rail Situation. Synopsis of Dr. Charles B. Dudley's address before the Am. Soc. for Test. Mat. 2500 w. Ir Age—June 25, 1908. No. 93302.

Examination of a 100-lb. Rail. G. B. Waterhouse. Micrographs and description of tests made, with results. 500 w. Ir Age—June 11, 1908. No. 92895.

The Rail Maker versus the Rail Consumer. G. B. Waterhouse. A short discussion of breakage causes from a steel-mill viewpoint. 1500 w. Engineering Magazine—July, 1908. No. 93398 B.

Stations.

The New Union Station, Washington, D. C. Fully illustrated article, with description. Plates. 2500 w. Am Archt—June 3, 1908. No. 92721 N.

The New Union Station of the New Orleans Terminal Company. Illustrated detailed description of a terminal for the Frisco system and the Southern. 600 w. R R Gaz—May 29, 1908. No. 92691.

See also Terminals, under PERMANENT WAY AND BUILDINGS.

Terminals.

The Fort Garry Terminal; A Union Station at Winnipeg, Man. J. D. Matheson. Map, perspective view, general plan, elevation, and description. 5000 w. Eng News—June 18, 1908. No. 93043.

The Fort Garry Station and Local Freight Terminal, Winnipeg, Manitoba. J. D. Matheson. Detailed description of station and freight yard, covering 70 acres, about to be constructed for the joint use of the Canadian Northern and Grand Trunk Pacific railways. Plans. 4000 w. Eng Rec—June 20, 1908. No. 93067.

We supply copies of these articles. See page 823.

Ties.

The Life of Steel Ties. W. C. Cushing. A discussion of the tie problem giving much information in regard to metal ties and their durability. 4000 w. R R Age Gaz—June 5, 1908. No. 92818.

Steel Ties on the Bessemer & Lake Erie R. R. Illustrated detailed description of the practice of this road in the use of the steel tie, its maintenance and operation. 3000 w. Ry & Engng Rev—June 6, 1908. No. 92846.

Experiments with Railway Cross-Ties. H. B. Eastman. A report of investigations by the Forest Service in coöperation with the Northern Pacific Railroad. 4500 w. U S Dept of Agri, Circ. 146—April 25, 1908. No. 93054 N.

See also Track Construction, under PERMANENT WAY AND BUILDINGS; and Piling, under CIVIL ENGINEERING, CONSTRUCTION.

Track Construction.

Standards of Track Construction on American Railways. Gives 5 tables compiled from special returns furnished by the engineers of the various lines showing the character of construction adopted. Also editorial. 8000 w. Eng News—June 4, 1908. No. 92850.

Rail Fastenings and Ties. Andrew F. Macallum. Considers the common spike, and the screw spike, tie plates, ties of timber, concrete and steel, composite, the spacing of ties, etc. 3500 w. Can Engr—June 5, 1908. No. 92837.

The Wedging of Rails in Chairs and the Metal Wedge (Le Coinçage des Voies à Coussinets et le Coin métallique). M. Chateau. Discusses the relative efficiency of wood and metal wedges, describes various forms of the latter, etc. Ills. 4500 w. Rev Gen des Chemins de Fer—May, 1908. No. 93108 G.

Track Inspection.

A Simple Track Inspecting and Recording Machine. Illustrates and describes the invention of T. Ellis, now in actual service. 900 w. Eng News—June 4, 1908. No. 92849.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

TRAFFIC.

Car Service.

Reducing Per Diem Charges Upon Freight Cars. F. Lincoln Hutchins. Considers means of effecting great saving in the change for car use and materially improving the service. 2500 w. R R Age Gaz—June 5, 1908. No. 92815.

Freight Cars.

Comparative Summary of Freight Cars in Service on the Railroads of the United States. Gives two tables, one covering 1900 and 1906, the other 1900 and 1907, considering 64 roads. 4000 w. R R Age Gaz—June 5, 1908. No. 92814.

Freight Handling.

The Measures Taken by the Northern Railway of France During Periods of Heavy Traffic (Note sur les Mesures prises par la Compagnie du Chemin de Fer du Nord pendant les Périodes de Trafic intensif). Albert Sartiaux. Describes the measures taken to secure the utmost efficiency of rolling stock, in freight handling, etc. 9400 w. Rev Gen des Chemins de Fer—May, 1908. No. 93107 G.

Freight Rates.

Railroad Freight Rates Too Low. Luis Jackson. Compares American and foreign rates, discussing present low tariffs, legislation, and the true basis of freight rates. 3000 w. Am Rev of Revs—June, 1908. No. 92913 C.

Relation of Rates to Commodity Costs. C. S. Sims. Gives results worked out on a number of articles showing the payment to the railroads for transportation of living supplies. 1400 w. R R Age Gaz—June 5, 1908. No. 92820.

New York.

Traffic Congestion in New York. George Ethelbert Walsh. Discusses the difficulties in handling merchandise and railway and steamship freight. 2000 w. Cassier's Mag—June, 1908. No. 93004 B.

MISCELLANY.

Accounting.

Railroad Accounting Under Government Supervision. M. P. Blauvelt. Address before the Assn. of Am. Ry. Acc. Officers. Discusses the attempt to have a uniform system, etc. 5000 w. Jour of Acc—June, 1908. No. 93363 C.

Railroad Cost Accounting. S. M. Hudson. Considers the necessity of developing a proper and just system of cost accounting, discussing necessary details and related matters. 3500 w. R R Age Gaz—June 5, 1908. Serial, 1st part. No. 92817.

Africa.

Note on the Waterval Boven Deviation. B. P. Wall. Describes a piece of railway construction in South Africa. Discussion. Plates. 4000 w. Jour S African Assn of Engrs—April, 1908. No. 92740 F.

Apprenticeship.

The Apprenticeship System. Report of a committee to the American Railway Master Mechanics' Assn. 3000 w. Ry & Engng Rev—July 4, 1908. No. 93508.

Austria.

New Railway Lines in the Austrian Alps (Les nouvelles Lignes de Chemins

We supply copies of these articles. See page 823.

de Fer dans les Alpes autrichiennes). F. Hofer. A general review with a particular description of an important masonry viaduct at Salcano. Ills. Plate. 3000 w. Génie Civil—May 2, 1908. No. 93124 D.

France.

The Redemption of the Lines of the Western Railway of France (Le Rachat du Réseau des Chemins de Fer de l'Ouest). P. Maurice. A discussion of the proposal now before the French Senate to open the procedure for taking over the lines of this railway by the State. Ills. Serial, 1st part. 7000 w. Génie Civil—May 16, 1908. No. 93128 D.

Government Control.

Relation Between Railways and the State. A résumé of what has been done in England toward railway regulation. 3000 w. Engr, Lond—June 5, 1908. Serial, 1st part. No. 92989 A.

The French Railway Companies and the State. An outline of the conditions which govern the French railway companies in their relations with the State. 2800 w. Engng—June 5, 1908. No. 92985 A.

Railroad Capitalization and Federal Regulation. Franklin K. Lane. Outlines a plan for interstate regulation and governing capitalization. 3000 w. Am Rev of Revs—June, 1908. No. 92914 C.

India.

Indian Railways. A résumé of the report on Indian railway finance and administration for 1907. 2500 w. Engr, Lond—June 12, 1908. No. 93230 A.

Management.

Concerning American Railway Management. An editorial criticism. 2500 w. Eng News—June 18, 1908. No. 93046.

Betterment Work in the Car Department. J. E. Epler. Details of betterment methods in this department of the Santa Fe. 2500 w. Am Engr & R R Jour—June, 1908. No. 92810 C.

General Tool System. An illustrated article considering details of the remarkably successful application of commercial tool methods to railway shop practice on the Santa Fe. 2400 w. Am Engr & R R Jour—June, 1907. No. 92813 C.

A Practical Drawing Office System. G. I. Evans. Detailed description of the system at present in use in the motive power drawing office of the Canadian Pacific Ry. 4000 w. Am Engr & R R Jour—June, 1908. Serial, 1st part. No. 92808 C.

Preventable Wastes and Losses on Railroads. Harrington Emerson. An outline of the methods by which losses could be reduced and ultimately eliminated. 6500 w. R R Age Gaz—June 5, 1908. No. 92816.

See also Accounting, under MISCELLANY.

Scotland.

Through the Scotch Highlands by Rail. J. F. Gairns. Describes and illustrates the picturesque country of the Highland Railway. Map. 6000 w. Cassier's Mag—June, 1908. No. 92998 B.

Valuation.

Valuation of Railroad Property in Minnesota. A. S. Cutler. An account of the methods used for obtaining and checking the information. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93388 N.

STREET AND ELECTRIC RAILWAYS

Accounting.

The New Classification of Electrical Railway Expenses. Willard Hubbard Lawton. Considers important points in the proposed classification and system of the Interstate Commerce Commission. 3000 w. Jour of Acc—June, 1908. No. 93364 C.

Bavaria.

See Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Car Barns.

Cottage Grove Avenue Car House of the Chicago City Railway Company. Illustrated description of a new fireproof car house for storing and repairing cars, and furnishing rooms for the comfort of employees. 2000 w. Elec Ry Jour—June 20, 1908. No. 93079.

Car Repairing.

Traction Equipments. C. H. Wickham. Notes on apparatus used in conjunction with tramcar equipments, the most common faults, and repair shop practice. 2000 w. Aust Min Stand—May 6, 1908. Serial. 1st part. No. 92882 B.

Cars.

The Pay-as-You-Enter Cars from an Operative Standpoint. Charles A. Coons. Explains the advantages and merits of the system. 1000 w. Elec Ry Jour—July 4, 1908. No. 93504.

Observations on Pay-as-You-Enter Cars by the Mechanical Man. W. H. Evans. Discusses certain features of these cars, and of fare-collection. 2500 w. Elec Ry Jour—July 4, 1908. No. 93503.

We supply copies of these articles. See page 823.

Economics.

See Municipal Ownership, under STREET AND ELECTRIC RAILWAYS.

Elevated Railways.

The Improvement and Extension of the South Side Elevated Railway, Chicago. Abstract of a paper by J. N. Darling, read before the W. Soc. of Engrs., describing the difficult work carried out on this line. Ills. 5000 w. Eng News—June 4, 1908. No. 92852.

Hannover.

Notes on the Hannover Street Railway and Electric Mountain Railways (Nota betreffende een bezoek aan de "Strassbahn Hannover" en eenige Elektrische tramwegen in het Bergsche land). Illustrated description of several lines. Serial. 1st part. 9500 w. De Ingenieur—May 2, 1908. No. 93186 D.

Interurban.

The Youngstown & Ohio River Railroad. C. W. Ricker. Illustrated description of a line which completes electric railway communication between Cleveland and the Ohio River. 3500 w. Elec Ry Jour—June 13, 1908. No. 92932.

Locomotives.

The New Ganz Three-Phase Locomotive C. L. Durand. Illustrated detailed description of the new type for the Italian railroads. 1800 w. Elec Rev, N Y—June 20, 1908. No. 93083.

Municipal Ownership.

The Financial Outlook for Electric Tramways. William R. Bowker. Discusses their successful operation as viewed from a municipal standpoint. 2500 w. Cassier's Mag—June, 1908. No. 93003 B.

Operation.

New York Central Multiple Unit Train Service. C. H. Quereau. Discussion of results on the suburban trains of the New York Central, showing that from an operating standpoint it is successful. 3000 w. R R Age Gaz—June 12, 1908. No. 92945.

Shops.

A Model Car Repair Shop. Committee report presented at the Niagara Falls Convention of the Street Railway Assn. of the State of New York. Plans. 4000 w. Elec Ry Jour—July 4, 1908. No. 93502.

Repairing a Commutator. C. L. Greer. Discusses trouble arising from the burning out of the mica between the commutator bars, and the remedy. 800 w. Elec Ry Jour—July 4, 1908. No. 93505.

Single Phase.

Electric Traction on the Midland Railway. Illustrates and describes some details of the single-phase section between Heysham, Morecambe, and Lancaster. 2500 w. Elec Rev, Lond—June 12, 1908. Serial. 1st part. No. 93219 A.

Electrification of the Heysham, Morecambe, and Lancaster Line. Illustrated detailed description of this single-phase installation on the Midland Railway. 4000 w. Engr, Lond—June 12, 1908. Serial. 1st part. No. 93231 A.

Midland Railway Electrification. Illustrated detailed description and official information concerning the first single-phase system in Great Britain, the branch line connecting Heysham, Morecambe, and Lancaster. 10000 w. Tram & Ry Wld—June 4, 1908. No. 93299 B.

Substations.

Instructions to Operators in Railway Converter Sub-Stations. J. E. Woodbridge. Instructions for the manipulation of the apparatus under normal and emergency conditions. 3500 w. Elec Ry Jour—June 13, 1908. No. 92933.

Subways.

Construction of Section 903 of the Bridge-Loop Subway, New York City. Explains changes made in the plans, and describes the work. Ills. 3000 w. Eng Rec—June 13, 1908. No. 92954.

The Problem of Capacity in Rapid-Transit Systems: Report of B. J. Arnold on the New York Subway. Review, with extracts from the report, and editorial comment. 4500 w. Eng News—June 4, 1908. No. 92854.

Subway Signalling.

The Block Signal Train Indicating and Emergency Safety Equipment of the Interborough Rapid Transit Co., in the East River Tunnels, New York City. Describes the operating equipment of the two tubes from Bowling Green to Borough Hall, Brooklyn. Ills. 2000 w. Eng News—June 11, 1908. No. 92937.

Mr. Arnold's Report on the Subway Signals. Extracts from the preliminary report giving details of the signal system and the proposed improvements. 2500 w. R R Age Gaz—July 3, 1908. Serial, 1st part. No. 93507.

Track Bonding.

A Unique Application of Thermit Welding on Shallow Rail. Illustrated description of work on a viaduct near New York City. 1200 w. Elec Ry Jour—June 27, 1908. No. 93327.

Train Despatching.

Despatching Trains by Telephone. W. W. Ryder. A report of the success with the telephone on the Chicago, Burlington & Quincy. 2000 w. R R Age Gaz—June 26, 1908. No. 93332.

Wales.

Rhondda Valley Tramways. Illustrated description of a line of interest because of the local conditions. 2000 w. Tram & Ry Wld—June 4, 1908. No. 93298 B.

We supply copies of these articles. See page 823.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or a book of twelve for $2.00; three books for $5.00.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.